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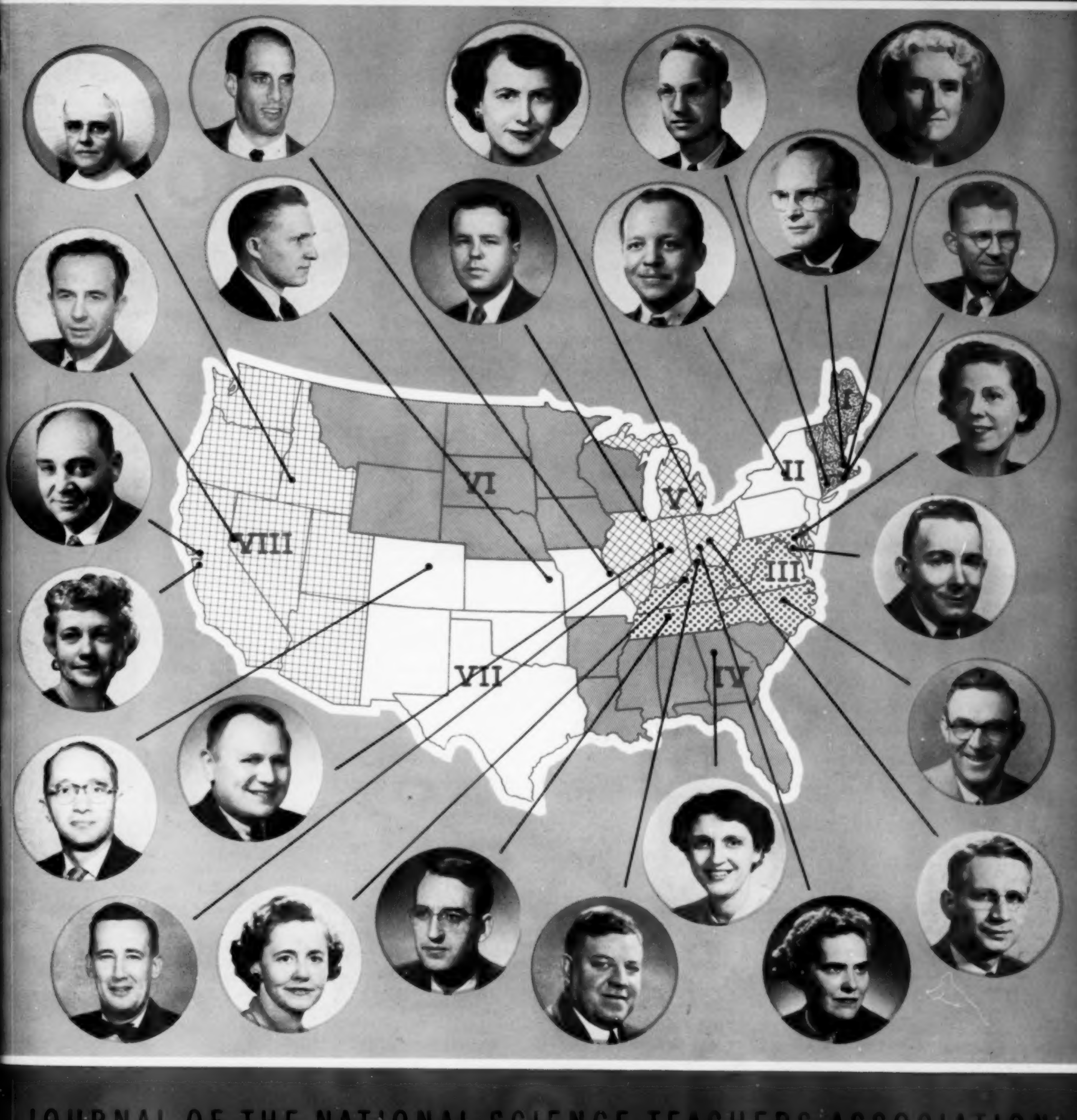
THE SCIENCE TEACHER



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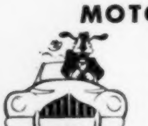

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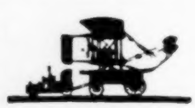

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THE SCIENCE TEACHER

Volume XXII

February through November

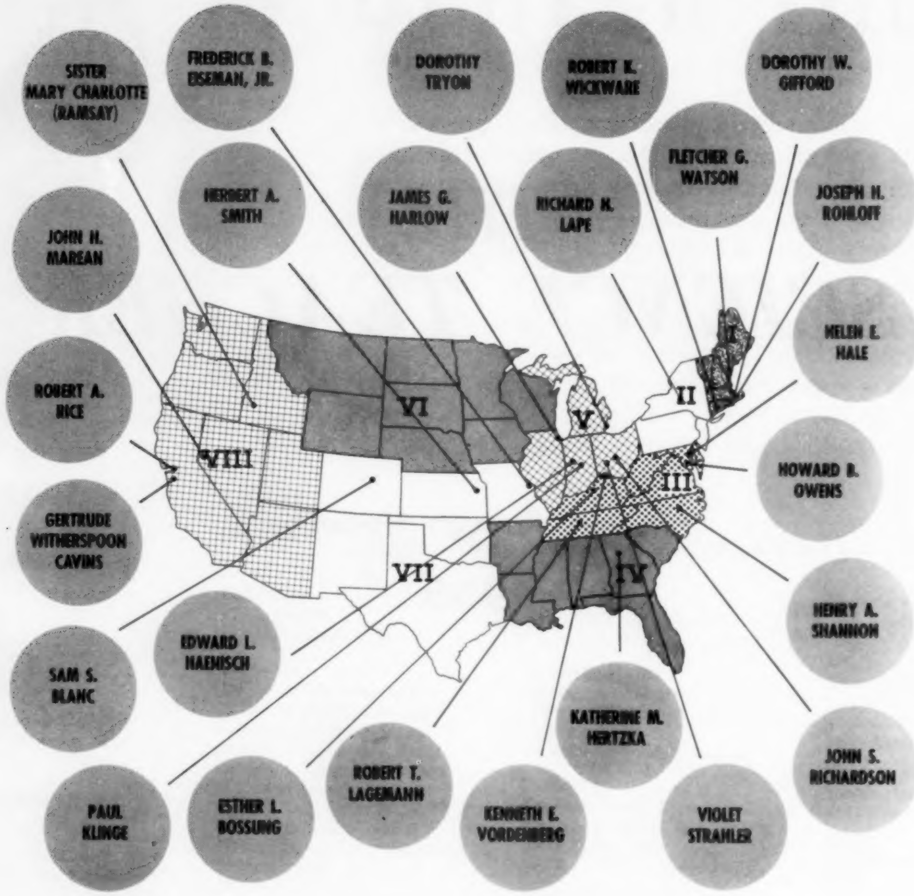
1955

Published by

THE NATIONAL SCIENCE TEACHERS ASSOCIATION

A Department of the National Education Association

1201 Sixteenth Street, N. W., Washington 6, D. C.



THIS MONTH'S COVER . . . presents the pictures of our 1955 candidates for NSTA Officers and Board of Directors. Designed by Mr. George T. Menish, this cover layout is a reminder to us to express publicly our appreciation of the helpful and creative assistance given by Mr. Menish in the make-up of *The Science Teacher*. He is a member of the staff of Judd and Detweiler, Inc., the printers of our journal.

Readers' Column

This letter concerns the article "Can Science Create Life?" which appeared in the November issue. The article thoroughly disgusted me. It has always been my idea that the method of science is a logical one. Separating the facts from the logic of this article, makes the conclusions most ridiculous. The scientific method is only ONE of the methods of arriving at TRUTH and should a scientist reject the other methods he would only be a scientist in name.

It is not my intention to fill this letter with criticism but rather to register disgust and protest concerning one article. I would like to say how well pleased I am to be a member of this organization and how much I enjoy reading *The Science Teacher*. It is generally a professional uplift and I sincerely hope that it always will be.

An Interested Science Teacher
St. Mary's High School
St. Louis, Missouri

I am very happy to accept your invitation to become one of the program participants in the Third National Convention of NSTA. My principal and superintendent both recognize the value of such conferences and are providing released time and partial reimbursement.

Robert K. Henrich
High School
Richland, Washington

Editor's Note. *We hope each year will bring many more letters with this message.*

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association, 1201 Sixteenth Street, N. W., Washington 6, D. C. Membership dues, including publications and services, $4 regular; $6 sustaining; $2 student (of each, $1.50 is for Journal subscription). Single copies, 50¢. Published in February, March, April, September, October, and November. Editorial and Executive Offices, 1201 Sixteenth Street, N. W., Washington 6, D. C. Copyright, 1955, by the National Science Teachers Association. Entered as second-class matter at the Post Office at Washington, D. C., under the Act of March 3, 1879. Acceptance for mailing at Special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d), Section 34.40 P. L. & R. of 1948.

MEMBERSHIP

The membership year coincides with the calendar year. New entries during the fall months extend through the following calendar year. Library and elementary school subscriptions coincide with the school year or run for one year from date of entry.

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Coming . . .

in the March issue of *The Science Teacher*

- The Significance of Pasteur's Attempt to Disprove the Theory of Spontaneous Generation
- Elementary School Science in the Making
- Evidence Awareness
- Cincinnati Convention Highlights

Editor's Column

One of my biggest satisfactions comes each year when the Nominating Committee reaches its decisions. What a wealth of talent and ability there is in NSTA!

Look over this year's list of nominees. You'll find enough degrees, experiences, and various forms of competency to refute *any* critic who says science teaching is not blessed with a very large number of highly capable teachers.

And the variation of species. In Region III, for example, we find an elementary school principal, a high school biology teacher, a state department supervisor, and a college professor of physics among the contenders. Sorry, "contenders" is not a good choice. None of these people sought office in NSTA. They have "risen to the surface" by various routes. All among them will gladly serve if elected. All among them will gladly serve if not elected.

This varied representation is one of the greatest strengths of NSTA. The most perplexing problems of science teaching respond best to solutions proposed by teams of *science* teachers. These teams gain strength through representation from elementary, high school, and college levels and from biology, chemistry, physics, and other science disciplines. You will find such teamwork displayed in the NSTA Board of Directors and in nearly all its committees.

—o—

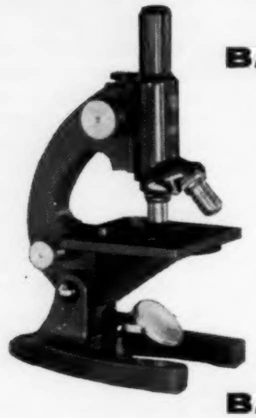
Another "biggest satisfaction" is the publication of the annual NSTA *Membership Directory*. This year's edition will contain about 8000 listings. These will be comprised of nearly 6000 individual members, over 1000 elementary school subscribers (representing about 14,000 teachers), nearly 1000 library subscribers, and about 180 members of the Business-Industry Section. Contrast this total with what NSTA was only ten years ago. At the end of its first year the full roster added up to 1715. The continued growth of the Association, not only in numbers but in services, materials, and positive influence in the profession, is eloquent testimony to the unselfish devotion and efforts of hundreds of individuals. This year over 500 persons are serving in active roles in helping to advance the Association's program. The pity of it is that with over 60,000 teachers of science in the junior and senior high schools alone, we are still reaching such a small fraction (about 1/10) on a direct, personal basis. That, of course, is a big part of the challenge, too! Many believe that our biggest opportunity and need is at the elementary school level. Watch for developments along this line during the next year or two.

—o—

Space limitations in this issue prevent us from bringing you the "special feature" we had planned, but we promise you'll find it in the March issue. NSTA Affiliated Groups have been known to many of you only by name; we know the brief reports on activities for the school year will properly introduce them to you and will be of interest.

Robert H. Carleton

3 WAYS TO MAKE TEACHING EASIER!



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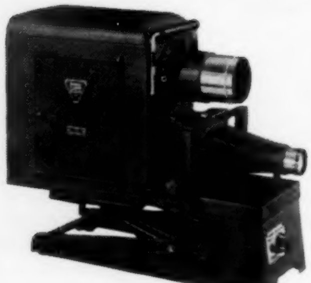

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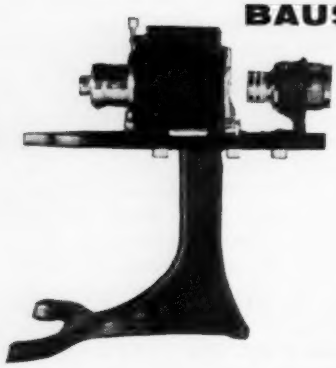

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THE SCIENCE TEACHER

Vol. XXII, No. 1 February, 1955

Articles published in THE SCIENCE TEACHER are the expressions of the writers. They are not a statement of policy of the Association or the Magazine Advisory Board.

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

THE EDUCATION TEAM[1]

By ALDEN H. EMERY

Executive Secretary, American Chemical Society, Washington, D. C.

EDUCATION starts in the home. It is continued through grade school, high school, college or university (both undergraduate and graduate), and one's place of employment. It is something that never ends as long as a person lives. One can not cover all these aspects in a single talk. They are mentioned only for the sake of completeness.

Home influence is great but too many of the "teachers" at that level are unqualified for their assignment. The schools too often must tear out the false foundations there provided before they can begin to build solidly. We must pass over this.

Elementary school teachers have responsibilities in the education team. Their pupils are at the age when they are naturally curious; this should be encouraged and satisfied insofar as possible. Many of the matters about which they have questions basically are scientific—Why is grass green?, Where does the sun go at night?, What makes wood burn? These curiosities should be nurtured. Grade school pupils are not too young to be shown the importance of an open mind. All this is a form of science teaching, a form quite different from that in high schools. Course outlines are less important than later but the subject cannot be ignored. If properly handled, it should influence the kind of instruction in junior high school and it, in turn, what is done in senior high school.

Since this conference group consists primarily of high school teachers, it is to them that I shall address what follows.

I like similes and this is a good place for one. No longer is it adequate for the chemist (or any other scientist) to think of himself in terms only of a little metal ring. No longer is it adequate for him to extend his thinking to lock that ring with others into a chain of all sciences. Today, that scientific chain must be interlocked side to side with other chains of the humanities, social sciences, business, and innumerable other fields to form a "coat of mail". The resulting fabric is complex, so complex that many are bewildered by it, do not have the interest or take the time to achieve understanding, and therefore shrink back into their own little link. The charm of the fabric as a whole and the beauty of its pattern are seen only by those who figuratively stand off at a distance and look at it with some perspective. This is the mark of an educated man.

In my opinion, it is one of the primary responsibilities of our public educational system to bring to the young and impressionable mind this viewpoint of the whole interrelationship of knowledge and of work and at the same time to help the individual identify that link or those particular links in the coat of mail which most interest him and to which he may wish to dedicate his life. Since the focus of the spotlight of specialization tends to become sharper as the individual progresses, responsibility for letting the illumination wander over a large area is most acute at the lower training levels. It starts in the home, continues in the grades, and by the time you high school teachers are moving the spotlight, you are on the threshold of sharpening the focus and limiting the sweep of the illumination. Thus, you take over at a most responsible period.

That sweeping of the spotlight involves supplementing or even correcting impressions from the home and environment. It must show youth the challenges that exist in various fields and the meaning of work therein to his fellow citizens. Focusing the spotlight involves fitting the patterns of an individual mental process and of individual abilities to the patterns of various disciplines. To some extent this must be done in a wholesale manner for you are required to think in terms of classes, not individual tutoring. But there comes a time at which the bulk treatment must be supplemented with individual analysis through individual consultation. This is not the job for a hack; it requires a specialist.

I do not mean the type of specialist who is so intimately acquainted with some narrow field within a single science that he can make reluctant molecules or cells do tricks but rather to a form of broad specialty that involves a working knowledge of the field as a whole, how it is used for the benefit of mankind, and the many opportunities for different types of mentality and different types of

[1]An abridgment of a talk presented before the NSTA Southwestern Regional Conference, Biological Station, University of Oklahoma, Lake Texoma, October 15, 1954.

personality and different interests within the field of his choice. Broad as this appears, it is in my opinion a form of specialization and the form required in your type of work.

"A chain is no stronger than its weakest link" is a well-known saying, but the strength of that link in life as well as in metallurgy involves a large number of steps in each of which attributes or properties are added. In life, one of the most important attributes involved in strengthening the link in the chain is *the ability to think, the ability to evaluate. The physical weakling must be defended against physical dangers; the mental weakling must be defended against mental dangers. If our educational system has developed mental strength in the product that it turns out, we never need be afraid of dangerous ideas,* for the person is equipped to evaluate them, to accept the right and to reject the wrong. This is a major challenge to our educators today. This is the forging of strength into each single link in the "coat of mail". This is another of the primary responsibilities of our educational system. You have responsibilities in this area as do teachers of other subjects. The sciences, if properly taught, will be an important means to giving the student the ability to sift the true from the false.

Subject Matter

A thorough knowledge of subject matter by the teacher is the greatest assurance of sound teaching in any field. Science as a whole and especially certain disciplines are changing so rapidly that the teacher who doesn't keep up with recent advances not only fails to present current information but has no pool of knowledge on which to draw to meet the specific and changing interests of his class. There is no quicker way to stifle interest than to make the students listen to what the teacher happens to known rather than for the teacher to pick his example from the fields which currently are in the public eye and about which the students are curious.

I am worried, deeply worried, by evidence that various scientific subjects in high schools are considered by some who set curricula simply as a little more knowledge to be stuffed into the heads of the students. Knowledge is wonderful but of limited use unless there is broader correlation with employment of that knowledge and with life as a whole. I believe this cannot be provided by the teacher with a thorough grounding in educational methods and limited training, perhaps a single course, in the subject field taught. In my opinion, successful high school teaching requires as thorough training in the subject used as that given to many who go out and earn their living in applying a single subject field to non-teaching pursuits, in industry, for example.

It is alarming to read reports about the inadequate training of some of those now teaching high school science. The quality of our science teachers is crucial. So is their number. There are many teachers whose college training provides a sound knowledge of some science and the necessary educational courses to qualify them for teaching under current laws. But, is that enough? I do not think so. Have proper facilities been provided to keep them up to date? I doubt it. Are the colleges and universities and the professions in any way failing in their responsibilities to such associates? In my opinion, the answer is "yes."

In *no field* of science does the knowledge which one gains in college remain adequate for any substantial length of time. To coast on it provides totally inadequate background for the students being instructed. The research specialist in industrial or academic work can select from the tremendous volume of scientific literature being published, those articles within his narrow field of specialty. The high school teacher cannot do so because his specialty encompasses the entire field of knowledge in one or more scientific disciplines. Most of our institutions of higher learning and our professional societies have not provided a mechanism by which high school science teachers can keep in touch with new developments as a whole.

While it is generally true that educational institutions are not meeting this challenge, there are some notable exceptions. The University of Delaware has a program leading to a master's degree in science teaching which includes many subject matter courses. It is interesting to note that this program is largely unsupported by outside funds and was started as a result of requests from high school science teachers who previously had tried to attend the University and could find practically nothing but education courses offered during the summer sessions.

Then, of course, there are the special conferences at several institutions across the country supported by grants from various sources. In the East there were the "Current Developments in Science" course at Harvard University and the MIT Science Teachers Summer Program, the latter financed by the Westinghouse Educational Foundation. This Foundation also sponsors a similar program at Carnegie Institute of Technology. General Electric Company has assumed the financial support of science teacher summer programs at Case Institute of Technology and Union College. In the Mid-

west, Indiana University's program to improve high school chemistry education through advanced training for teachers was supported for the first time this summer by the Standard Oil Foundation, Inc. of Chicago.

Still farther west, and also a new venture, was the West Coast Science Teachers Summer Conference for which the Crown Zellerbach Corporation provided funds and which was administered by your own NSTA. This was unique in that it sought to acquaint teachers through firsthand experience with the techniques used by scientists doing research. Through visits and interviews with more than thirty research scientists came ideas for new exercises, 27 to be exact, for school science laboratories. These now are available to classroom teachers [2] and it is hoped that the exercises will give a fresh approach to laboratory instruction.

This is not a complete listing of summer conferences for science teachers but its percentage of completeness is high enough to provide some cause for concern. Even if the number of such conferences were multiplied ten times, the proportion of the science teachers reached would still be small.

Summer Programs

What about the professional and scientific societies and their recognition of the need for a special kind of summer program for high school science teachers? So far as I know, only the American Chemical Society has done anything. Its first step was taken this summer. I see no reason why this program cannot be translated into other areas of science equally well.

For five years, our Division of Chemical Education has sponsored an annual summer workshop for chemistry teachers, but until this summer participation had been limited to college and university teachers. In 1954, for the first time, high school teachers were included and at the workshop held at Kenyon College, participants were evenly divided between high school and college levels. This summer, also, there was another innovation in that to the normal 10-day workshop, of which two were sponsored, was added a 5-week institute made possible by financial support from the National Science Foundation and the Fund for the Advancement of Education (Ford Foundation), again with participation of both high school and college teachers.

In this undertaking is a mechanism by which the college teachers can make clear to you what kind of preparation they want for the persons whose training they are to carry on. You, in turn, have the opportunity to make clear some of the problems that limit your ability to accomplish ideal training. Thus, from this can come a better understanding, with teamwork substituted for criticism. Indeed, at one of the sessions there was mutual consideration of what should be the content of a general chemistry course in college and how the high school teachers should prepare people for it.

Also in such workshops or institutes, both of which names are poor, lies a mechanism for presenting the latest developments in theory and application, material that you can use but which can be obtained from scientific literature only through great effort. In the short span of five weeks at Laramie last summer, over 100 teachers were briefed on the most recent advances in analytical, biological, inorganic, organic, and physical chemistry. It would have required months of diligent study to cover the points reviewed so expertly by men working daily in one or another of these fields. Yet, this is not a universal cure-all.

Even the mechanism is opposed by some because of the limited number of persons it can reach. Still to be solved is the problem of adequate academic credit for such work so that the time spent may be reflected not only in improved teaching material but ultimately in advanced degrees which lead to increased financial return. Indeed, I should recommend that more collegiate institutions take cognizance of this situation and develop their own summer courses for high school science teachers along these lines so that the centers for work of this kind can be more widely distributed and the opportunities more generally available. However, all the responsibility cannot be placed upon the educational institutions. *High school teachers must point out to the institutions why their conventional graduate courses are not suited to their needs.* With enough reminders of this type, change will occur. It has in certain institutions, the University of Delaware, for instance, and there is no reason why the idea cannot spread. You can help in your states.

An aspirin to relieve the discomfort of a headache may not eliminate the cause but it provides temporary relief which permits more efficient functioning for a time. It would be proper to direct our thoughts to what might be the aspirins in the situation we face, the temporary relief until some of these more permanent corrective measures can be implemented generally. Again let me use as my example the field of chemistry and its major professional society, the American Chemical Society, because it is the undertaking with which I am most

[2] See special supplement, pp. 25-40, this issue of *The Science Teacher*.

familiar. What we have accomplished and what we feel might be done, certainly can be adapted to the organizational structure of other scientific disciplines.

Within the territory of our 147 local sections, live 85 per cent of the population of the United States. With relatively small effort, we can contact roughly 85 per cent of the science teachers. The American Chemical Society utilizes its local sections as a means to implement the program of the organization as a whole. The extent of their undertakings is limited only by finances and by the wishes of the local section which, in turn, is influenced by the wishes of its members.

Within the past few years, under the direction of Dr. B. R. Stanerson of the ACS headquarters office, our local sections have been subject to repeated urgings to extend their activities at the high school level. The opening wedge was to offer services to you in the field of vocational counseling. All have been encouraged to go much further and some have accepted this challenge until in certain localities extensive programs have been developed. This information is circulated among all local sections with suggestions that as much as possible be implemented.

In several localities there have been organized efforts to obtain summer employment in chemistry for teachers of chemistry. The aim of that program has been not only to provide a little extra income but to give a direct insight into how the science you are teaching is applied; it is hard to say which aspect has been considered more important. We believe this will be expanded.

Local sections also have financed attendance of high school teachers at educational conferences. Seventeen sections sent 35 teachers to the Kenyon workshop, previously mentioned. Two others appropriated funds for this purpose but were unable to find anyone who had not previously made plans for that 10-day period.

Still other local sections assist teachers by arranging industrial plant trips; maintaining a loan library of films on chemical subjects; providing speakers for career conferences and other meetings; serving as consultants on projects, textbooks, curricula, and laboratory equipment; and providing various teaching aids. One section has set up an extensive advisory service under which any teacher with a specific problem can call one individual and immediately through a card index which he maintains be put in touch with the member of the section best qualified to give advice. It has been used extensively.

I started by designating this type of activity as an aspirin. Perhaps a better medical simile would be to call it a vitamin, for while it is a temporary palliative, at the same time it is not a pain killer but rather an aid to increased vigor which is not, perhaps, the whole cure but at least is a substantial contribution.

We have brought to the Engineering Manpower Commission and to the Scientific Manpower Commission our thinking in this field of high school education. A joint committee of EMC and SMC recently has rendered a report on what the two Commissions and their constituent societies can do. I am not modest when I speak about the American Chemical Society and, therefore, am frank to say that what has been recommended to all is similar to the present program of the ACS. The basic principles have been endorsed by the two Commissions and passed along to their constituent societies. Consequently, programs of the type from which I have drawn illustrative material in my remarks soon may be in operation on a broader basis. For this the ACS asks no credit but we have pride in our part in setting the pattern.

Career Counseling

The high school teacher must play an important role in counseling students on a career choice. Where the chemical profession has suffered in the past—and the reason that some years ago we launched an extensive program of vocational counseling—is that the opportunities in chemistry and chemical engineering have not been presented adequately or accurately at the high school level to those choosing, even on a tentative basis, a field for future work. Much the same could be said of your own field. We do not want to over-glamorize what the chemists and chemical engineers do. We do not want to paint a picture of a bed of roses. Probably most chemists and chemical engineers have found chemistry and chemical engineering a satisfactory area for their efforts but, at the same time, not one would indicate that it is without its drawbacks and without its problems. The latter never should be minimized. We want presented to the student under your influence the true picture of what is ahead if he selects chemistry or chemical engineering as his field of endeavor. I am certain that scientists in other disciplines would make a like statement about their own professional areas. We need to have some fitting of the student's interest, background, and mentality to the line of effort to which he will direct his attention in his next educational step. Equally we need to have eliminated those persons who will not achieve a high degree of competence in such fields. That cannot be overemphasized. At least in chemistry, we are not interested in mass recruiting but in selection. We are interested in quality, not quantity. I am sure I speak for physics, biology, earth sciences, and many other disciplines when I make that statement on behalf of my own field.

It is heartening to note that NSTA has published a new booklet, *Careers in Science Teaching*. This should be helpful to you and we hope it will stimulate greater effort on your part in encouraging the right young people to enter the high school science teaching field. The big problem is to get the right people in the right places. This is the challenge in counseling.

A Look Ahead

The impact of science upon our citizens and upon civilization is tremendous. In spite of some current misconceptions by the public, we have added to the health, safety, and well-being of mankind. What we can do in the future can be surmised only if we make comparisons of the present with the past, for we are far from approaching the limit of accomplishment. The man most valuable in our civilization today is the one who wants to contribute to the well-being of his fellow men. You have a place in that picture in your preparation of youth for their life work. You have an opportunity to steer these people into the fields in which each can make his maximum contribution and from which he can derive his maximum satisfaction in living. It is an opportunity; it is a challenge.

Since the beginning of my remarks, I have not used the term "The Education Team," which is my subject; but, I haven't talked about anything else. The problem that faces you and me and our associates is to weave a "coat of mail" for civilization in which there is no weak link. Your responsibility is no greater than that of the home, of higher education, or of employers, but neither is it any less. We cannot make progress toward a better life for all without recognition of this interdependence, without recognition that our individual contribution is of importance, without acceptance of the responsibility for making that contribution the best possible one, without a willingness to turn to others for that assistance that is essential. On the one hand, I ask for the humble attitude involved in such sharing of responsibilities and credit and, on the other hand, I pay tribute to you as key members of a team that extends through all civilization and on which all civilization depends.

Elementary School Science

Integration of Science with Other Subjects

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SCIENCE, like other instructional areas, must be considered in relation to the aims and purposes of the total elementary school program. We believe that the main purpose of our schools should be to acquaint students with meaningful experiences which they can use in living with the most success and happiness to themselves and the greatest benefit to others.

Science offers a wealth of classroom opportunities to meet the needs and interests of all by encouraging the observing and studying of real, enticing and vibrant life situations. In science probably more than any other subject area we can help the child find answers to his many questions: What is that? How does it work? Why does this happen?

Since children are normally interested in exploring their natural and scientific environment, science can be treated as a window through which the child's experiences in other subject areas can be enriched and integrated into a clear and meaningful picture. It should not be treated as a separate entity but should be taught in its true relationship to our world and our way of living.

Integrating science with the other areas of the curriculum opens many new features of these learning areas to the children. Many subjects now presented in mere book form or through cut-and-dried methods can be greatly enriched through the inclusion of science. The child will be given a wider vista of the subject and stimulated to greater heights of achievement. The subject matter can be lifted from the pages of the book and made a living situation. The child will thus receive a greater insight into the material being presented and will also have an opportunity to develop in all the areas of growth.

In the remainder of this article the writers will present some of the ways in which science has been integrated with the other areas of the curriculum in the later elementary grades of the Northside and Eastside Schools of Niles, Michigan.

Science and Language Arts. Many teachers in later elementary grades are interested in having their children learn to express themselves through the medium of the language arts. To do this, oftentimes teachers assign some sort of written work which may take on the cloak of "busy work."

One of the fourth-grade classes in the Eastside School has successfully integrated science with the language arts. The teacher says science easily fills the need for a stimulus in composition work. She has used her language class for the group to recall experiences which they have had and to compare them with the experiences of others.

The pupils also wrote up the experiments that were conducted in the science class, and wrote out plans for new experiments. Written reports to be placed on the bulletin board or made into science booklets, and the summation of field trips have been used very effectively in this class. All the rules of good writing were put in force but the situation resolved from a mere writing class to a living situation. The study of nouns, adjectives, and verbs seemed to take on newer meanings as the children used them through the eyes of science.

Careful reading is also necessary. The pupils read the directions for the experiments, then after making the experiments they reread and checked their information. Questions often arose during a discussion in science, leading children to look up the subject in different science or reference books. The children were encouraged to present their findings to the class.

Science and Social Studies. In order to effectively study any country or peoples we must integrate social studies and science. The children realize a much deeper understanding of a country and the way its people live when they learn that the mineral wealth of a country, or the lack of it, the topography, the climate, the agriculture, and the industry, for example, are largely dependent upon some phase of science.

During the study of South America, one of the sixth-grade classes made a terrain map of the area. In order to do this the pupils had to learn to read intelligently a physical map, how to construct a

scale model, and how much material would be needed. They mastered the technique of the building of maché mountains and the best colors to use to indicate the Andes Mountains, the plains, and the Amazon Valley. By leaving this map as a part of the permanent classroom teaching aids, the class left a challenge for future students.

The pupils studied the different topics as they needed the information and not according to a schedule. The teacher says it was seldom necessary to assign supplementary reading material because as soon as the pupils exhausted the material in one book they went on to another if they felt they needed additional information.

An aftermath of this project was carried on by the children in their homes on their own initiative. They returned to school with colored maps and charts showing the rainfall and climate of South America, and with paper maché maps and maps or charts cut from plywood showing the mineral deposits and chief industries of the various countries of South America. All these projects reflected the originality of the individual student.

It would be very difficult for a teacher to conduct a meaningful discussion of the agriculture of a country without calling upon science to explain conditions necessary for plant growth and how crops are harvested and processed. By planting seeds in the classroom the pupils in a fifth-grade group gained a deep appreciation of the importance of good seed, soil, fertilizer, sunlight, moisture, and other factors in the growing of plants. After this study the children could easily explain why certain crops are grown in certain areas of our country and how important these crops are in the lives of the people. This classroom project had a nice carry-over into out-of-school life as many of the pupils transplanted their plants at home.

The sixth-grade at Northside School became especially interested in rubber while studying Brazil. They found that certain scientific knowledge is necessary for an understanding of the history of rubber and its application to our everyday living. The class divided into groups to study different aspects of the subject. They found that science has played an important part in the taming of the wild rubber tree and the establishment of rubber plantations. One group made a world map showing the distribution of these plantations. Another group made a scale model of a modern rubber plantation.

The children were amazed to learn how quickly our scientists and industrial engineers were able to produce synthetic rubber in the quantities we needed during World War II. Using brown and green modeling clay some of the pupils made a

A sixth-grade social studies class studies rubber. The three pupils on the left side of the table are making a model of a modern rubber plantation. The four boys on the right are working on a synthetic rubber molecular model. The girl in the background is working on the frieze depicting the history of rubber.

model showing how the hydrogen atoms and the carbon atoms might fit together into a synthetic molecule.

Another group wrote and presented a play showing how we use many of the rubber products science has given us in our everyday living.

Science and Arithmetic. Recently the fifth-grade of Northside School made a trip to a near-by electric light plant and during the tour the pupils discovered that it took two lines to carry the electric current. When the class returned to school each child estimated the distance from his house to the plant and found how many feet of wire were necessary in order for him to have electricity in his home.

The pupils were also shown how electricity was measured. This measurement was used in figuring how much their electric bill should be for a month.

As a follow-up on the trip to the local plant the class studied about the many great hydro-electric plants throughout our country. In connection with this study a group from the class drew a large outline map of the United States to show the location of many of these plants.

Science and Art. Our teachers report that they are never at a loss for interesting subjects in art work, and that the children receive a deeper appreciation for art and its place in our world through combining the beauty of art with the realm of science. By noting the colors nature has developed in plants, flowers, and marine animals, the children in another fourth-grade room, and a fifth-grade room, learned, with a great deal of meaning, the beauty of blending colors, and how colors are used

to express ideas and beauty. By closely observing their tropical fish aquarium they not only learned a great deal about the scientific aspects of fish life, but they also observed how colors change the appearance of an object.

Science and Health. Science has done a great deal to improve the general welfare of people. Science and health were integrated in a fifth-grade class when studying how scientific discoveries have improved our general health and increased our life span. Through the study of germs, bacteria, and medical discoveries the pupils learned how many of our diseases are combated.

We would like to give you one eyewitness account of an experiment as recorded in another fifth-grade classroom.

A health book said that the pupil of the eye is a hole through which light passes. The children expressed their disbelief. So, they decided to try to get the eye of some animal from a local meat packing plant, if possible, and see what could be discovered. The next day Fred came to school with two cow's eyes.

They decided to operate on one eye and leave the other intact. Knives that were too dull served only to wreck that eye. A razor blade made a perfect division of the other eye. Great was their astonishment when they discovered that they could see a paper towel through the pupil. Just to be certain, someone put a pencil under the eye. Seeing was believing. The pupil really was a hole.

Behind the pupil was a transparent, jelly-like mass, the lens, which they discovered enlarged objects.

The other half of the eye was lined with a thin greenish-blue, rather shiny layer—the retina. One youngster asked if that was what made the color of our eye. "No," said another. "This eye was dark in color." Then they found the iris they were looking for around the pupil.

About this time, a couple of boys checked with a chart of the eye which was on the bulletin board. Yes, the chart was right. They had seen those parts with their own eyes. Their disbelief was replaced with a, "Now I understand it."

Science and the Whole Curriculum. Another fourth-grade teacher was very successful integrating science with other subjects by encouraging her children to make models of animals they studied in science out of paper maché.

In order to do this the children studied the lives of the animals, where they lived, how they lived, what they ate, their physical structure, and their appearance in various poses. They learned how to make paper maché and mix paints so as to simulate the original animals. All this required a great deal of reading and research work. The children increased their knowledge of arithmetic while planning how much paper, paints, and other materials they would need, how large to make the model, and how to pose their creations.

The unit of work was culminated with a display of the animal creations and the giving of reports both oral and written. Many of the details were worked out in groups so there was opportunity to plan and work together.

In a project such as this the teacher must work very closely with the children so that they do not lose the continuity of the whole learning experience. Without this the project could become merely a consumer of time and energy.

Conclusion. The integration of science with other subjects through these activities had one major point in common. The activities led the pupils to identify themselves with the subject at hand, rather than viewing it merely through the pages of a textbook. They called upon all the skills and resources of the people involved. The children were given an opportunity to express their creative abilities. Skills taught beforehand were put to use and many new ones were learned in the process.

Can Chemistry Contribute to General Education?

By CLYDE E. PARRISH and WALTER KELSON

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A STUDENT IS OVERHEARD saying, "I don't like science classes because there is no room for original ideas. All you can do is learn existing facts and theories." Unfortunately too many science classrooms are managed in such a way that original thought is stifled. The totalitarian quality of the classroom coupled with an overpowering body of knowledge too often operates to exclude thinking of an original nature.

Do you teach in a way that creates a situation like the one described above? The authors feel that the answer is too often *Yes!* If the answer to this question is yes there is yet another question. That is what to do to correct the situation so that creativity and original thinking can enter the classroom. The following article describes the answer to the question as it was developed and used by the authors.

The general purpose of this classroom experiment has already been expressed. More specifically it might be broken into two main parts. The first main purpose is to examine a teaching method with the intent of evaluating its worth. The second main purpose is concerned with opportunities offered to the student.

The second purpose is threefold. One is to encourage student initiative. Another is to extend student participation in classroom activities. The third is to extend laboratory manipulations to include experience in demonstrating.

Certain basic assumptions or hypotheses were tested by the authors' experiment. They are as follows:

1. A formal chemistry class can be organized to permit individual initiative and original thought.
2. The efficient learning of chemistry is possible in a democratic atmosphere.
3. There is room for considerable self-direction in a classroom populated by students 15 years of age or more.
4. Learning one special phase of chemistry quite well is more desirable than learning a wide variety of chemical facts in nominal fashion.

The chemistry textbook used for basic organization was *Chemistry and You* by Hopkins, Smith, McGill, and Bradbury. The first six units of this book cover the basic items concerning all matter such as the nature of acids, bases, and salts and the writing and balancing of chemical equations. The remaining units are concerned with specific elements and chemicals or groups of chemicals. They provide opportunity for applying the background obtained in the first six units.

Five units were chosen for consideration. They carry the titles *Sulfur, A Family Tree, Nitrogen, The Good Earth,* and *Metallurgy.* The Sulfur unit includes a discussion of oxidation-reduction reactions and A Family Tree includes a discussion of the halogens, the periodic chart, and atomic physics.

Three chemistry classes participated in the experiment. Committees were created for work on each unit. Three committees, one from each class, worked independently on the development of each unit. The smallest committee had three members, the largest had six members.

The developmental period covered seven school days. It was given over to working demonstrations, finding experiments that the entire class could do, and making exercises to be given out as assignments. Some people devoted time to finding persons in the community who could come into the classroom for a talk or demonstration. Others arranged for films and made other visual aids.

The presentation of all five units covered a period of seven weeks. The seven weeks contained three holidays and also permitted two days for discussing and evaluating the method that had been used.

Previous to the introduction of this block of work the classes had been following a rather formal pattern. This pattern involved question outlines and discussions held by the teacher. Demonstrations and experiments were also an integral part of the program. In an effort to orient the students to the change in the organization the teacher prepared a written description of what he had in mind. This was given to each student along with information concerning the subject matter to be involved. This was supplemented by comments from the teacher and the answering of questions asked by various students.

Very little attention was given to motivation as an initial concern. Individuals were given advice and suggestions when they asked for it or when they very evidently needed it. A great deal of latitude was permitted throughout the experiment as far as behavior was concerned. The idea was to determine what checks could be used to keep behavior within reasonable bounds without resorting to completely authoritarian methods.

Some of the individual highlights of the entire experiment were:

1. Construction of enlargements of elemental segments of the Welch Periodic Chart of the Elements. Three persons made such enlargements. Their study in doing so made them relative experts on the Periodic Chart. It also provided colorful material for hanging in the classroom.
2. Two boys undertook the job of making recordings of the vocal portion of a demonstration on the halogens. Again the individuals involved in the preparation benefited greatly.
3. One of the persons undertaking the explanation of oxidation-reduction reactions learned to handle such equations with a degree of proficiency well above the rest of his class.
4. Several students utilized a flannel board technique previously used by the teacher, to illustrate important parts of their discussion.
5. Several good films were made available to the classes through the efforts of students. In two instances the parents of students made arrangements through their places of employment.
6. Due to the proximity of Stanford University and its scientific laboratories one of the students was able to contact a professional glass blower. He gave two demonstrations that were witnessed by all students of physical science classes.
7. The community has a very active adult education program. One of the students contacted an adult education instructor of ceramic art. She invited all three chemistry classes to her workshop and spent three hours of her time talking and demonstrating for them.
8. Several people undertook experiments in hydroponics with varying degrees of success. The most ambitious effort was devoted to determining growth differences due to the absence of one of the vital elements in the nutrient solution.

Additional observations of a more critical nature are listed as follows:

1. The amount of work done by each individual varied a great deal. Members of the same committee showed too much variation in the responsibility that they assumed.
2. All of the students, to a greater or lesser degree, evidenced need for training in organizing material for study and for presentation. The students, as well as the teachers, became strongly aware of this fact.
3. The initial preparation time was used incorrectly. Primary emphasis should have been given to organization. Enrichment items should have had secondary emphasis.
4. The preparation period could be shortened and a free day introduced between each unit.
5. One of the things observed by the teachers was the seeming lack of respect for each other that students displayed. This contributed and often created the *laissez-faire* condition that kept recurring in all three classes.
6. The natural leadership qualities of some class members was very well used. Some of this leadership came from unexpected quarters and other students did not live up to prior expectations.
7. This type of class organization gives the teacher time to observe and assess students in a more deliberate and thorough manner. Guidance can be based on more than subject matter proficiency.
8. Largely due to their efforts to compose exercises and tests many students expressed a sympathetic understanding for the role of the teacher.
9. The experience gained by the students gave them a basis for opinions concerning the relative merits of teaching methods.

The purpose that brought this experiment into being was well served. It did provide room for individual initiative and original ideas. In the opinion of the involved teachers the degree of freedom necessary for permitting originality need not be as great as that permitted in this experiment. Whether the freedom is to be very broad and relatively unlimited will depend on the teachers willingness to risk a *laissez-faire* situation and also on the nature of the social group comprising a particular class. It may also depend on the development of subtle techniques for discouraging the *laissez-faire* condition. Subsequent efforts on the part of one of the authors has proved effective. He maintains a tabulation of recitations and out-of-turn talking. The students are aware of this record. It has curbed indiscriminant conversation and increased volunteer recitation.

One more comment about initiative or self direction is in order. Many students lack skill in the use of initiative. Due to this they need a great deal of guidance in the form of suggestions. Many times they have not been encouraged toward having original ideas and as a result do not know what to do, or at best they resort to an undesirable form. This situation becomes less conspicuous as the students gain experience. This experience might be

created by a readiness program that would gradually build and extend responsibilities assumed by students.

In accomplishing the additional purpose of increasing student participation in both vocal and manual ways the program served in mediocre fashion. Many students resorted to a lecture or report form of presentation. They did not attempt to draw the class into active discussion of their particular topic. Others did do an excellent job of combining report and discussion. Considerable dissatisfaction was expressed by students regarding the tendency simply to give a report. A plan for removing the danger of reports was worked out. The need for basic organization was given consideration and worked into the plan as its basic component.

Students and teachers together decided that a basic outline of each piece of work should be made in the future. This was tried quite successfully. Six units which broke down into 23 subdivisions were parceled out among members of each class. Each student outlined a segment of the work in a fashion prescribed by the teacher. The teacher with three samples of outlining for each segment of work consolidated and corrected them. A skeleton copy of the consolidation was given to all members of the classes. They then completed the skeleton as an exercise. The student making the original outline for his class conducted the discussion centered around his outline. He also enriched the discussion by appropriate demonstrations and by the use of other enrichment materials and techniques.

Testing by means of a teacher-made test at the end of the experimental period showed no difference in the amount of chemistry subject matter learned under experimental methods and that learned under more conventional methods.

In learning a special segment of chemistry subject matter in very thorough fashion many students discovered an interest that they have pursued considerably farther than was demanded by the classwork. This plan therefore offers a means of allowing for individual differences in ability and interest.

It is hoped that this article will serve as a help to other relatively inexperienced teachers who wish to attempt methods that are new to them. The experiment showed that both teachers and students need experience with a new method of classroom organization before either can appreciate its worth. The involved teachers experienced considerable discouragement, much of it growing out of the lack of motivation of the classes as units. It is questionable whether motivation of a desired nature can be effected until the students have acquired a basic experience with the method. Too many teachers give up before the experience is acquired. This experience is necessary in order for students to make comparisons and pass judgment. They, like their teachers, have a tendency to hold to the familiar, well known methods. Because of this they will be quite unwilling to try something new until they can see an advantage in doing so. Somehow that advantage must be demonstrated. Possibly a mock demonstration of the method could be presented to the class involved. It could serve as a means of pointing to the various factors that give the method an advantage and it could point to the need for properly handling the basic organization.

Experience, however, seems to serve best. Also, success is difficult to measure when there is considerable uncertainty about its definition. Teachers in particular can learn much in undesirable situations if they refuse to panic and stick it out.

One thing that is of vital aid in any situation is the conference that is possible if more than one teacher is working on a teaching project. The teacher and student-teacher relation existing in this instance proved to be ideal in that respect because both teachers observed the same situations and then discussed them thoroughly. These discussions led to a critical evaluation of all situations that arose. Each was examined for good aspects and bad aspects and the two balanced against each other to determine which predominated and whether the situation could be recreated in improved form.

The information acquired by the involved teachers makes them feel that the experiment was a worthwhile effort. It led to a teaching pattern that is, in the opinion of the authors, better than the one used prior to starting the experiment. The experiment also made the students' need for training in organizational techniques strikingly apparent.

SCIENCE EDUCATION RESEARCH AND THE CLASSROOM TEACHER*

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WITH the exception of the field of reading, more research has been carried out in the field of science education than in any other subject-matter field. While it is impossible to ascertain accurately the number of science investigations undertaken annually, a reasonable estimate would be thirty or forty in the field of elementary science, and perhaps one hundred fifty in the field of secondary. Many of these, of course, are never published and hence the findings never disseminated. As is true with all educational research, coordination of the investigations in science education is almost always lacking. Few, if any, investigators team up to attack the problems of science education on a broad scale.

However, from the studies that are reported it would seem reasonable that reviews should be made periodically to consolidate their findings and determine their implications for classroom teaching. The implications outlined in the report that follows, are summarized from studies in science at both the elementary and secondary levels, and are categorized under logical headings. Since the numbers of studies from which they are obtained are great, no effort will be made to document them.

I. What Are Feasible Objectives of the Teaching of Science?

Research evidence makes it eminently clear that the teacher who emphasizes the learning of scientific facts probably does little more than temporarily tax the memory processes of the student. Within a short time after the science course is completed, whether at the elementary or secondary level, nearly everything of that nature is forgotten. This refers to the memorization of such elements as the names of species in biology, rocks in earth science, the periodic table in chemistry, or energy equivalents in physics. Such elements are remembered only when they are taught in terms of usage and application. It is therefore reasonable to suggest that the objectives of science teaching should be the elements likely to be retained rather than those that are forgotten. Research would indicate also that the abilities related to (1) applying principles of science, (2) habits of critical thinking, and (3) skills in problem solving are retained long after courses are completed. Hence, the aim of science teaching should be to develop these objectives by means of factual experiences. This would seem analagous to the aims of the field of mathematics in which students learn mathematical skills by means of problems. They are not expected to remember the specific problems.

II. What Published Materials Are of Value in Teaching Science?

Research shows that there are many published materials—textbooks, pamphlets, government bulletins and commercial materials—of value in science teaching. This is true for all levels. However, it has been found that the textbook is still the best source of foundational material for science courses. A number of teachers have eliminated the use of the textbook and have attempted to use supplementary materials and references as the foundational material. The time and effort involved in assembling such material has not been justified by the results they obtained. The term "supplementary" is well applied to such materials.

Research evidence points sharply to one fact concerning both textbooks and reference materials. They vary a great deal in their levels of reading difficulty (many being too difficult for the students for whom they are designed) and style of presentation. Hence, a teacher must spend some time in examining these sources for factors other than elements of content, since a textbook or other type of reference material should be designed to clarify science concepts, not challenge the student with its difficulty.

* A summary of two reports delivered at the Second National Convention of NSTA, April 2, 1954, Chicago, Illinois.

III. What Is the Best Method of Motivating Students to Study Science?

The number of studies dealing strictly with motivation in science teaching is limited. However, the psychological studies dealing with motivation, and the few dealing with science interest, do offer enough evidence on which to base some conclusions.

Up to the age of late adolescence the word "interest" is a rather dubious term to apply to the motivations that a student may have. Probably the term "curiosity" is more accurate. In general one might say that interest in young people is ephemeral and is dictated, at any moment, by the intensity, and social value, of a stimulus. Hence to select students for scientific training on "interest" much before the senior year of high school is probably unjustified.

The ephemeral motivations of course offer excellent means for "leading in" to the study of scientific, as well as other, areas. However to assume that expressions of scientific curiosity at this age are valid criteria for inducing students to accept scientific careers is probably most unwise.

The best way to motivate children to study science is found in psychological, rather than in science education, research. A well-trained enthusiastic teacher has proven to be the greatest form of motivation. With the child, pubescent, and adolescent motivation tends to be extrinsic rather than intrinsic. Hence, motivational factors are more likely a function of the teacher than the student himself. One must therefore seek to motivate students, rather than to hunt for characteristics inherent in the student, at these grade levels.

IV. What Are the Best Types of Curriculum Enrichment?

Many studies have compared the relative merits of field trips with those of motion pictures, projects with those of club work, film strips with those of microprojectors and so on. In some of these studies certain types of enrichments have seemed more effective than others. Yet taking these studies as a whole one generalization seems obvious. The effectiveness of any enrichment device depends on factors other than the device itself. All enrichment devices are valuable when used under favorable conditions. Probably the best plan is to vary the type of enrichment from time to time in order to sustain the "interest" of the student. It may well be suggested that any further study of relative merits of various enrichment devices or techniques is a waste of time. Such studies should be devoted to determining the best ways to use the various devices.

V. What Are the Optimal Methods for Evaluating the Outcomes of Science Instruction?

The question just posed is a "sixty-four dollar" one to which there isn't a five-cent answer! Evaluation in the field of science education is a sadly neglected area. It has long been recognized that, in order to be effective, evaluation devices must measure professed objectives. In science such objectives are functional understandings of the major principles of science, development of habits of critical thinking, and growth in problem-solving skills. All research efforts devoted to evaluation in science education have shown that nearly all tests measure essentially the accumulation of scientific facts and seldom the other objectives just named. The items on tests which do claim to measure these objectives are of low validity or else have not been validated. Also such tests are cumbersome and time-consuming to administer.

It is surprising to note also, despite the fact that classroom teachers are the greatest manufacturers of tests, little research has been done in the preparation of tests at the classroom level. Further, most of the studies dealing with tests have used the tests as research techniques rather than objects of investigation.

In addition to the needs in the area of informal testing there is a great need for the study of methods by which the progress of students in scientific skills may be evaluated from day to day. This would indeed be consistent with the point of view that evaluation is a continuous process.

VI. What Is the Present Professional Status of the Science Teacher?

While few studies have been undertaken that deal directly with the professional status of the science teacher, many have dealt with the need for science teachers, as well as their professional training and their academic competencies. From these studies a number of implications may be drawn.

There are not enough science teachers to fill the jobs now available. Further the people who are teaching science seldom have the breadth of training necessary to teach the generalized courses that most of them have to teach. In most states a vast number of science teachers teach only one science class, an "extra" assigned to them in order to have a teacher in the classroom. Further, despite the ever-increasing need for greater numbers of well-trained science teachers, the numbers are getting no greater and the training is getting no better.

Unfortunately little or no research seems to be devoted to the solution of the problems here indicated. This is quite unfortunate since the status

studies carried out over the past several years have all pointed to the same difficulties. Yet little effort seems to be exerted to change the situation.

VII. What In-Service Programs Are Now Available for Science Teachers?

The average science teacher has a great deal of difficulty keeping up-to-date because of the dynamic nature of science. Hence it would be reasonable to assume that colleges and universities would provide subject-matter courses that would enable them to make up their deficiencies. Several surveys made of possible science courses for teachers show, that with few exceptions, institutions of higher learning offer only advanced courses in science that are designed for majors in science, rather than for teachers. A few schools offer courses such as "Recent Advances in Biological Science," "Geology for Teachers," and "Problems in Physical Science." Yet the number of institutions who offer such courses are much too few to meet the needs.

Summary

Obviously only a small portion of the research studies in science were reviewed in this study, and a number of the major areas of science education were not included. The authors selected those that seemed to ramify most directly into the experiences of the classroom teacher. Several generalizations may be drawn:

1. There seems to be a sufficient number of status studies, the type that point out the elements of the immediate situation. There is however a dearth of studies that attempt to find remedies for glaring deficiencies. Perhaps a moratorium should be declared on all research in science education except those that attempt to *solve* problems.

2. There is a need for more team research. There are vast numbers of studies in nearly all areas of science education. However, the problems and techniques of related studies tend to be sufficiently different so that it is almost impossible to draw valid generalizations from them. It would seem that some agency, perhaps the American Educational Research Association might well attempt to coordinate research in science education.

3. More research in science education needs to be focussed on problems that the classroom teacher faces from day to day rather than on identification of objectives, etc. An examination of the research studies would tend to indicate that many still dwell in the abstract rather than on the practical. Further it might be well for researchers in science education to review the research carefully before embarking on other studies.

SUMMER INSTITUTES, CONFERENCES, AND FELLOWSHIP PROGRAMS FOR SCIENCE TEACHERS

An NSTA Staff Report

DURING THE SUMMER OF 1955, at least a quarter million dollars will find its way into the pockets of some 500 science teachers. The teachers will use the money to cover expenses of participation in a dozen or more sponsored programs specially designed to provide new knowledge and ideas in the various science disciplines and in teaching techniques. The renewed professional enthusiasm which the teachers will gain from their experiences is a major by-product of the over-all effort. Collegiate credit applicable toward degrees and salary advancements is a feature of most of the programs.

A few of the summer programs produce published reports through which others than the actual participants can benefit. NSTA's 1954 West Coast Conference on the improvement of laboratory teaching is reported in the 16-page supplement to this issue of *The Science Teacher.* The conference involved 32 teachers working as a research team and using interview techniques in contacts with more than 30 research scientists from college, industrial, and governmental laboratories. The program was conducted by NSTA's Future Scientists of America Foundation and Oregon State College on a grant of $10,000 from the Crown Zellerbach Foundation.

The report of the Southeastern Conference on Biology Teaching held at the University of Florida, August 28-September 6, has been published as the January issue of *The American Biology Teacher.* The 64-page report summarizes the recommendations of the 96 people in attendance on how to improve biology teaching in high schools and colleges and how state departments of education can assist in the development of strong biology programs, particularly in the Southeast. The ten-day conference was sponsored by the National Association of Biology Teachers in conjunction with the annual meeting of the American Institute of Biological Sciences on a grant of $15,000 from the National Science Foundation. Single copies of the report are available free from Dr. Richard L. Weaver, Co-Director, School of Natural Resources, University of Michigan, Ann Arbor.

Most of the summer programs, however, depend on the values of self-improvement of the participants and a degree of "rubbing off" of their renewed enthusiasm and know-how among their colleagues. How effective this is may not have been established statistically, but no one who has talked with any of the participants can doubt that the programs are producing significant results. As testimony, here are excerpts from a report submitted by Marvin J. Jones, Head of the Science Department, Lanier High School, Macon, Georgia. Jones was a Westinghouse Fellow at MIT last summer.

"How long has it been since you attended a course in your subject field? Haven't you wished many times that you could take some courses at a good school in order to refresh yourself in your subject, to learn some of the latest developments that take so long to get into the textbooks? It must be very expensive. Maybe; but you can afford it, for you may be unaware of the opportunities and financial help available.

"For the past six years the Westinghouse Education Foundation has sponsored a refresher course for secondary science teachers from all over the United States and Canada at MIT for a period of six weeks. Each summer fifty science teachers from public and private secondary schools are awarded Westinghouse Fellowships of $250 to enable them to attend the course. I spent about $100 more than this, including travel, books, meals, lodging, and sight-seeing.

"The course included sixteen classes in chemistry and five chemistry laboratory sessions. There were fourteen lectures in physics and five laboratory sessions. These provided a review of the more important fundamentals, in many cases with an entirely new slant on the subject. Lecture assistants prepared dozens of demonstrations and these gave many new ideas for use 'back home' with our own classes. Some of the topics covered by the lectures were biological catalysts, cosmic rays, giant molecules, radiochemistry, food research, metallurgy, meteorology, and electrostatic and magnetic accelerators. We came in direct contact with fifty or more of the MIT faculty, most of them top men in their fields. What an inspiration a high school science teacher can get from this!

"Visits to labs and industrial plants are most interesting and instructive. You *see* processes and equipment in action—things you may never have seen before. Professors, graduate students, and trained personnel are present to discuss and explain their work to any one who shows the least bit of interest.

"It was wonderful to meet and talk with so many experienced and qualified science teachers from widely scattered points. We gave and received valuable 'tips on teaching' that will influence our teaching and our students when we return to work. There was plenty of time for fellowship, sight-seeing in and around historic Boston, browsing in the library, or just plain loafing. By writing a paper or doing a project of our choice, we could earn four semester hours credit. What an ideal way to go to school! I am returning to my school with renewed enthusiasm and fresh knowledge. I wish that more industries or other organizations would make it possible for more science teachers to have this kind of valuable experience."

THAT QUARTER MILLION DOLLARS IS THERE—and part of it can be *yours*, just for the asking. It's almost that simple. Where the programs are, their limitations if any, what they offer, and how to apply are itemized in the following paragraphs. These represent the extent of information available to NSTA at the time of this writing. For information on fellowships offered by the Fund for the Advancement of Education for 1955-56, *write to the National Committee on High School Teacher Fellowships, 655 Madison Avenue, New York 21, N. Y.*

Pennsylvania State University. About June 15 for six weeks. High School Science Institute. Primarily for physical science; supported by grant from National Science Foundation. *Write to Dr. William Powers, Director of Arts and Science Extension Service.*

University of New Mexico. About June 16 for four weeks. Institute for College and High School Physics Teachers. Supported by grant from National Science Foundation. *Write to Dr. John R. Green, Department of Physics, University of New Mexico, Albuquerque.*

Fisk University. June 16-24. Chemistry Conference. Open to high school and college teachers; supported by grant from Fund for the Advancement of Education; sponsored by American Chemical Society's Division of Chemical Education. *Further information available from Dr. Sam Massey, Chemistry Department, Fisk University, Nashville, Tennessee.*

St. Louis University. June 20-July 29. Institute for Teaching of Chemistry. Master's degree program featuring advanced work in chemistry with supporting work in physics, mathematics, and education; also, lectures and visits to industrial and research laboratories. Twelve $280 Fellowships provided by the du Pont Company available to high school teachers; open nationwide. *Apply to Dr. Theodore A. Ashford, Professor of Chemistry, St. Louis University, St. Louis, Missouri.*

Oak Ridge Institute of Nuclear Studies. August 1-26. Institute for physics and chemistry teachers, featuring nuclear science and radioisotopes. Open nation-wide; limited stipends available; supported by grant from National Science Foundation. *Apply to Dr. Ralph T. Overman, Institute for Nuclear Studies, Oak Ridge, Tennessee.*

West Coast Science Teachers Conference. August 12-26. Conference on math skills and abilities useful in science. To be held at San Jose State College, California, in cooperation with NSTA's Future Scientists of America Foundation and the National Council of Teachers of Mathematics; supported by a grant from Crown Zellerbach Foundation. Open to teachers of science and mathematics in grades 7-12 in Washington, Oregon, California, Utah, Idaho, Arizona, and Nevada; thirty-two $200 Fellowships available. Closing date for applications May 1; forms may be

(Please continue on page 51.)

NEW IDEAS FOR SCHOOL SCIENCE LABORATORY ACTIVITIES

A Report of the
1954 WEST COAST SCIENCE TEACHERS' SUMMER CONFERENCE
August 13-27
Oregon State College, Corvallis, Oregon

Conducted by
Future Scientists of America Foundation
of the
National Science Teachers Association

In cooperation with
Crown Zellerbach Foundation
and
Oregon State College

NEW IDEAS FOR SCHOOL SCIENCE LABORATORY ACTIVITIES

How and Where Ideas Were Obtained

Thirty-two science teachers were selected by the Future Scientists of America Foundation and, with financial aid provided by the Crown Zellerbach Foundation, assembled at Oregon State College. Their names appear on page 40. Acting as a research team, these teachers visited and interviewed more than thirty research scientists regarding projects in progress in their laboratories. During these visits the teachers observed the content or subject matter and the methods and strategy involved in the projects. On occasion, the men were asked directly to advise the teachers regarding the improvement of school science laboratory activities. A brief reference to each interview appears in "Science Teachers Explore Research" in the November, 1954, issue of this journal.

Observations acquired during the interviews were given a sharp look from the point of view of the years of successful experience represented among the teachers. Those implications which are within the potential of school science laboratories were retained and translated into recommendations and observations. In turn, all recommendations had to be expressed in examples of modified laboratory exercises or, when necessary, in sketches of new exercises.

A Preview

The body of this report consists of three sections. So that the reader may know "whereof we speak," the first section presents samples of the laboratory visits and interviews which provided the data upon which recommendations were based. The recommendations form the second section. The third section presents the suggested laboratory exercises which can be used to put these recommendations into practice.

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SAMPLE INTERVIEWS

"Identification and Control of Virus Diseases in Stone Fruits"—Dr. John Milbrath, Plant Pathologist, Oregon State College.

The original problem of diseased trees was brought to Oregon State College by farmers engaged in the production of stone fruits, cherries, plums, and peaches, at present a sizable investment in Oregon's economy. Some trees were diseased, stunted, and malformed; cherries were undergoing progressive shrinkage, color change, and splitting. The fruit growers expressed their alarm by insisting that the State College take over the problem and work out a solution. Such was the general problem and temper when Dr. Milbrath was introduced to the problem of virus in stone fruits by the county agent.

By inspection he recognized that these symptoms were not caused by irrigation, spray, dietary deficiency, bacteria, or fungus. A virus infection seemed to be the only plausible explanation. To test his hypothesis, he grafted diseased cherry stock on healthy trees, demonstrating the organic transmission of the virus. The next step was to carry out similar tests on all varieties of cherry trees available. Dr. Milbrath and his associates are working on the following possible solutions (trying to classify and develop), 1) resistant strains, 2) use of chemical inhibitors, and 3) indexing to find healthy trees for the propagation of nursery stock. In this manner virus-free cherry stock has been propagated and distributed to growers and nurserymen with resulting greater cherry yield.

One of the unsolved problems is the possible existence of latent virus which may become active after several years. Research of this type is limited by the mechanics, in this case, the slow growth of trees.

Dr. Milbrath presented the following implications worthy of consideration and digest by science teachers:

1. New science information to enrich science instruction. There is no substitute for up-to-date subject matter and the implications involved.
2. A comprehensive background in chemistry seems desirable for life science majors.
3. Virus and their tremendous impact upon the world of applied science must be included in presentation of modern biology courses.
4. Use of the group method as problem solving

technique allows greater insight into the problem. In college research, chemist, biologist, biochemist, physicist, and statistician all work on a common problem. Presentation of this technique of knowledge-sharing can begin at lower levels.

5. Present a problem in as many ways as possible.

Dr. Milbrath then associated the following general information on virus, suitable for study and discussion on the secondary level. Suggested method of presentation might be:

I. Identify the topic and distinguish from bacteria, fungi, protozoa.

II. Discuss relative size of known viral particles and compare to large molecules.

III. Discuss with proper diagrams and implications, phage, rickettsia, virus.

1. Virus are transmitted organically.
2. Virus must be inside a cell to grow and reproduce.
3. Virus may retain identity outside a cell for an unknown amount of time. Records show where virus kept in culture medium or cold storage have retained identity and life ability for over fifty years and will infect the cell when reintroduced.
4. Pathological symptoms caused by virus in plants may be transmitted by mechanical rubbing, by insect vectors, and possibly by several ways as yet undetermined.

The electron microscope aids the study of virus diseases.

PHOTO BY OREGON STATE COLLEGE NEWS BUREAU

PHOTO BY CROWN ZELLERBACH CORPORATION

The research team combined interviews in government, industry, and industrial research laboratories.

5. Virus in plants display their activity by varying methods so a single symptom as a diagnostic tool is not feasible.
   a. Some cause local lesions, e.g., alfalfa mosaic in bean leaves.
   b. Some cause mottling of leaves or flower parts, e.g., variegated poppies, camelias, and related plants.
   c. Some cause morphological modifications such as witches broom in delphiniums and evergreens.
   d. Some cause stunting of stone fruit trees.
   e. Some cause a progressive stunting of fruit, such as in cherries where the cherry shrinks in size until it is no longer of commercial value.
   f. Virus also show specific activity as demonstrated in associated plant relations. Gladioli harbor an inactive virus with no visible symptoms apparent; however when beans are planted near gladioli, the virus is transmitted and kills the bean plants, the virus becoming active.
6. It is becoming very apparent that plants are just as susceptible to virus as animals and, as research continues, in time it may be demonstrated that plants have as many virus diseases as animals.

7. Types of cancer demonstrated by both plants and animals are known to be virus caused.
8. Bacteriophage have been definitely associated with virus.
9. Tobacco mosaic virus and other larger types have been photographed with the electron microscope (90,000x). These photographs can be obtained to assist in virus study.
10. Virus and their implications have opened a complete new field in the natural sciences and in the field of biochemistry.

"Representative Research Projects of the Paper Industry"—Dr. W. M. Hearon and Associates, Assistant Director of Research, Crown Zellerbach Corporation, Camas, Washington.

Crown Zellerbach Corporation operates their Central Research Development Laboratories and Pilot Plant for control of paper quality, research for new paper products, for better paper products, for use of by-products of paper making, and for research on pollution of streams by paper making wastes inherent in the manufacture of paper.

Once a problem has been suggested by a needed mechanical improvement, a necessary process, or an improvement of an existing product, the Process Laboratory takes the problem. Research is developed through the test tube stage, to the pilot plant and, finally, to commercial production. One such problem is obtaining fibers that have been beaten in the proper manner so that the binding power can be improved and stronger paper manufactured. After inquiry into the actual nature of the fiber to determine what causes binding between fibers, mechanical and chemical environments are developed to produce these optimum binding effects.

During their stream pollution research efforts, the Development Laboratories reclaimed a chemical sold under the trade name of Orzan. This chemical gives promise of many future uses such as soil conditioning, ore dressing for the flotation process, dust settler, fertilizer, and as a base for adhesives.

Crown Zellerbach is assuming its civic responsibility for stream pollution abatement. In the development of this problem, the research team has developed a waste liquor 40% solid and 60% water which is disposed of by atomizing and burning in a furnace much the same as fuel oil. The heat generated is used to evaporate additional waste liquor to make more fuel.

Dr. Hearon and his staff have done considerable research on the profitable utilization of spent sulfite liquor. It presents one of the largest and most challenging problems faced by the industry today. The pulping industry is almost unique as a user of less than 50% of its raw materials. The other 50% contains lignin and resin, the lignin mainly in the form of lignin sulphonic acid diluted by the large volume of water added in the process of pulping. All of the liquor of the Camas mill is dumped into the Columbia River at the present time, but research and development along these lines may lead to utilization of all the liquor.

Possibly the largest potential for the liquor lies in using it as a raw material for the production of pure organic compounds. In the chemical analysis of the liquor, conidendrin was found to exist to the extent of 1% in hemlock liquors and lesser extent in fir liquors. Chemists working in the Department of Agriculture found that conidendrin both in alpha and beta forms was a good antioxidant.

Since the chemical was present in the liquor and there was a use for it and a possible market, the Development Laboratory began a project of research on the most economical method of extracting conidendrin from the liquor. Two possible solutions were found: (1) adding trichloroethylene or (2) adding toluene; both cause alpha and beta forms of conidendrin to precipitate. The toluene method, being more adaptable to large scale production, met with favor.

If all the liquor of the Camas mill was treated it would produce 6000 pounds of conidendrin daily. To date the production of conidendrin has passed the pilot stage and full production now depends upon obtaining commercial outlets for the product.

"Representative Research Projects Underway at Reed College"—Drs. Arthur F. Scott, Arthur H. Livermore, M. W. Cronyn, and Associates, Department of Chemistry.

Reed College represented a unique experience to the group exposed to this fine campus. Dr. Scott portrayed the traits demonstrated by people engaged in pure research. Outlined for us were six problems in research being studied by Dr. Scott and his staff. Simultaneously they are working with peptide bond linkage, hyaluronic acid, biological effects of radiation, chemical determination of atomic weights, carbonyl synthesis, and the use of iodine in medicine as it pertains to cancer. Set rules, known techniques, or specific methods do not limit them nor is time a regimenting factor. The results obtained are in the field of pure research and may be used by any persons concerned.

This philosophy which functions in science at Reed College is further demonstrated by using student research to fit the student. No student is discouraged, but rather is channeled into research that he can successfully complete. Dr. Scott makes full use of students' capabilities, and, as he said, "Student activities suggest ideas, which suggest ideas to me, which I in turn suggest to the next generation."

Among the varied research projects at Reed College, Dr. Livermore was investigating Peptide Bond Synthesis. It was hypothesized that two separate enzymes hook the glutamic acid, glycine and cystine system together. How could these enzymes be isolated? In answer to this question radioactive tracers and paper chromatography techniques were employed. Yeast grown in culture provided the enzymes that were to be isolated. The initial problem remains unsolved with research continuing.

Dr. Cronyn's project was under the auspices of the Heart Society of Oregon and has an indirect relationship with rheumatic fever and arthritis. Ingeniousness on his part enabled him to isolate pure, costly, hyaluronic acid. This substance, found in vitreous humor, was obtained by extracting it from the quick frozen eyeballs of cattle. Pure hyaluronic acid is to be used to inject animals in an attempt to find an inhibitor. Dr. Cronyn hopes that phosphyorlated hesperiden may be just such an inhibitor. If a successful inhibitor could be found it would be a decided advancement in the control and therapy of rheumatic fever and arthritis.

The biochemical effects of radiation were being investigated by various science department staff members at Reed College. With the increased use of radioactive materials, foresightedness in radioactive research may prove most fruitful. One effect already noted was the decrease in protective effect of certain colloidal systems by the use of irradiated gelatin.

RECOMMENDATIONS

1. Full advantage should be made of the science teacher's position to inspire students to follow a science career.
   - A. Interest in science research might be developed by the science teacher carrying on a personal research project.
   - B. The need for adequate guidance has been evident in helping students develop paths of interest. It is recommended that science teachers be given the opportunity to take a more active part in the counseling services of high schools. It was evident from our visits that the field of research holds many opportunities for qualified persons.
2. Individuals have a variety of talents which should be utilized in a team approach to science projects. The combined skills of the team enable it to cut across subject matter lines. Technical knowledge must go hand in hand with on-the-job personal adjustment. We recommend the possibility of teachers and students in chemistry, physics, and biology working together with radioisotopes, virology, and other similar topics.
3. The researcher should have the skill of spelling out the value of his work to others—both with written and oral reports. Presentation to a group for discussion and evaluation is a valuable technique to use in science laboratory activities.
4. Current technical library materials are immediately available in research laboratories. We recommend that science teachers establish a library of current pamphlets, periodicals, texts, and other reference materials within the bounds of the science department.
5. Scientific investigation should reveal interesting information while showing an ever widening field for study. Methods may be used to explore the steady process of change in the environment and of man's part in the changes. We can impress our students with the truth that the day of opportunity is not over. If you can't find something new to do, do the old thing better.
6. Modern processes deal with such minute and such exact tolerances that more emphasis should be placed upon training in cleanliness, precision, and meticulous attention to detail in scientific laboratories. There should be no reason for distinction between training laboratories and research laboratories in these respects.
7. Science teachers should maintain and encourage an attitude of receptiveness to new concepts and techniques. We have observed that research scientists do not hesitate in this matter in the solution of their problems. Such techniques and concepts observed during this

conference are: chromatography, the use of radioisotopes, use of inhibitors as blocking agents, and the use of statistical methods to increase reliability of experiments.

8. The Edisonian, or "trial and error," method of approach to a problem is far from dead in today's research laboratories. After all logical approaches have been explored it still may be necessary to encourage students to "try it and see if it works."
9. Researchers find it necessary to keep a chronological log containing the day to day progress of current research and experiments. Memory being unreliable, as student research activities more nearly approach their industrial, governmental, and educational counterparts, and are extended over longer periods of time, it becomes necessary to maintain enduring records of the individual's daily progress.
10. The ability to recognize a problem, to see the approach(es) to its solution, and to recognize pertinent facts are measures of the individual's success in scientific work. The development of these abilities in the individual student is the obligation of the science program.
11. It is the responsibility of the science team to recognize and develop latent superior talent, and to encourage the student who possesses it to develop along broad fields of social, economic, and scientific learning. This will permit him to qualify readily for positions in the vital fields of administration and supervision in science-related institutions and industries.
12. We recommend that science teachers make full use of all local facilities at their disposal. Implications for experiments can be gained from visits to business, industry, colleges, and resource people. If laboratory problems or research are undertaken under limitations of facilities, time or finance, then ingenuity and resourcefulness are essential.
13. Additional values of laboratory experiences may be gained by
    A. A consideration of the economic feasibility of materials or methods;
    B. Tracing the necessary steps in interpreting a research development through the pilot plant stage and into industrial reality.
14. A functional use of statistics and graphical representation has been found to be of vital importance in science activities in interpreting and evaluating new information, and should, therefore, be a part of the science training for high school students. For example, experiments could be designed using sampling techniques.
15. Industrial and research laboratories are designed to be adapted to a wide range of problems. Selection of school laboratory facilities and equipment should be made with an idea of flexibility, mobility, and replacement due to obsolescence. This will enable teachers to keep their science program up-to-date with new developments and techniques in science and in science teaching. For example, mobile carts may save time and reduce loss and breakage.
16. The school administration should provide and science teachers should use a specified period for preparing, repairing, and storing laboratory materials and equipment.
17. New products and techniques should be accepted with reservation until exhaustive tests indicate the implications of their use and justify their unreserved adoption.
18. Personnel involved in research activities showed a marked loyalty to their project, their associates, and their organization. Loyalty on the part of the student to his work, his teacher, to other students, and to the school should be a by-product of good science teaching.

SUGGESTED LABORATORY ACTIVITIES

Editors' Notes: The thirty-two teachers were sharply divided on the question of how specific and detailed the direction for student science laboratory activities should be. Since there was neither time nor objective data to resolve this question, the exercises which follow are reported as they were suggested by individuals or small groups. The form in which they are reported may, in itself, suggest ways to improve laboratory job sheets or instructions.

EXERCISE 1. TO DETERMINE THE EXTENT, IF ANY, TO WHICH FRESH WATER FISH ARE AFFECTED BY STREAM POLLUTION.

MATERIALS:

1. A fresh water stream.
2. Two wire or plastic mesh boxes which can be submerged and made escape-proof.
3. Accessibility to an area at the source of pollution on the stream.
4. A supply of 100 healthy, even-aged fingerling fish, preferably of the game variety and definitely approved by the state agency in control

of such fish. Choice of a species occurring naturally in the stream would be advisable.

PROCEDURE:

1. Submerge 50 fish in one live box at a point in the stream above but close by the point of pollution.
2. Submerge the other 50 fish in the second live box at a point below the place of discharge where the pollutant is evenly dispersed in the stream water.
3. Take water samples at points of location of live boxes at daily intervals; determine and average the degrees of pollution.
4. Check live boxes for mortality and debility at daily intervals and record data until live boxes are removed.

CONCLUSIONS:

1. Record your findings.
   a. Fish in live box from polluted water.
   b. Fish in live box from non-polluted water.

QUESTIONS FOR DISCUSSION IN CLASS:

1. If you found that one live box produced more dead and sick fish than the other, what explanations are there for the difference?
2. What does this exercise mean for people who use the stream for recreational purposes?
3. If it was found that the live box in the polluted water produced more harmful effects upon the fish than the other, why would you or why would you not . . .
   a. call a game warden?
   b. repeat the experiment?
   c. report your findings to the state fish commission?
   d. tell the polluting agency what you found out?
   e. put the results of your experiment away without taking any action?

EXERCISE 2. CAN PLANT VIRUS BE COUNTED BY A SIMPLE LABORATORY TECHNIQUE?

MATERIAL:

1. Two week-old bean seedlings.
2. Dry virus-infected alfalfa.
3. #400 mesh carborundum powder.

PROCEDURE:

1. Powder alfalfa with mortar and pestle.
2. Place 1 g. of powdered alfalfa in beaker and add 10 ml. of water.
3. Mix thoroughly and filter.
4. Transfer measured amount of filtrate to surface of leaf of two bean seedlings.
5. Sprinkle leaf with carborundum and with finger rub into surface of leaf. This allows the carborundum to pierce leaf cells and admit virus. Exercise care not to induce undue mechanical injury.
6. Care for seedlings until lesions appear.
7. Count lesions and record number. Convert this number to number per gram of alfalfa.
8. Make several dilutions of filtrate, repeat steps 5-8, and graph the results.

QUESTIONS:

1. What factors might reduce the accuracy of the count?
   a. Control these factors where possible and repeat the experiment.

BACKGROUND PRESENTATION FOR THIS PROBLEM:

1. Virus particles cannot reproduce outside of living cells.
2. Alfalfa mosaic virus is widely distributed. Infected plants will show a yellow mosaic pattern throughout. Samples of viral alfalfa may be obtained from the nearest Agricultural Experiment Station.
3. Bean seedlings will not become systematically infected with the alfalfa virus. Local lesions will demonstrate the infection of the virus, each lesion representing the invasion of a single virus particle. This reaction shows a hypersensitivity of the plant to this virus.
4. Mosaic virus can be mechanically transmitted to living cells if the cell is punctured to facilitate vital injury. Puncturing should not kill the cell.
5. Each resulting lesion represented a hypersensitive reaction and is assumed to have been caused by a single viral body.

EXERCISE 3. TO DETERMINE THE EFFECT OF VARIOUS VIRUSES ON THE SURFACE OF BEAN AND TOMATO LEAVES.

MATERIALS:

Bean plants, tomato plants, dried tobacco leaf (from cigar or cigarette), fresh spinach leaf, dried alfalfa root, fresh corn leaf, potato tuber, #400 mesh carborundum.

PROCEDURE:

Grind samples of 1 g. dried tobacco leaf with #400 mesh carborundum, adding sufficient water to produce a viscous liquid. Dilute liquid

$\frac{1}{10}$ and brush on surface of leaf of bean and tomato plant. Dilute $\frac{1}{100}$ and $\frac{1}{1000}$ and repeat.

Follow the same procedure using the fresh spinach leaf, dried alfalfa root, fresh corn leaf, potato tuber.

Make daily observations and record them.

HYPOTHESIS:

1. Indicate what you think may have occurred.
2. What evidence do you have to support your statements?
3. How could you further test your results?

EXERCISE 4. TO SHOW THE EFFECT OF AN INHIBITOR ON TOBACCO MOSAIC VIRUS.

MATERIALS:

Dried tobacco leaf, fresh spinach leaf, #400 mesh carborundum, bean plants, tomato plants.

PROCEDURE:

Grind 1 g. tobacco leaf with 5 ml. of water and ½ g. carborundum. Brush on a leaf of bean plant and one of a tomato plant. Repeat the procedure using: (1) 1 g. fresh spinach leaf plus ½ g. carborundum. (2) ½ g. dried tobacco leaf and ½ g. fresh spinach leaf plus ½ g. carborundum.

Make daily observations and record them.

HYPOTHESIS:

1. Indicate what you think may have occurred.
2. What evidence do you have to support your statements?
3. How could you further test your results?

EXERCISE 5. TO DISCOVER THE EFFECTS OF POTATO PLANT VIRUS AND TOBACCO MOSAIC VIRUS ON BEANS AND TOMATO PLANTS.

MATERIALS:

Potato tuber, dried tobacco leaf, #400 mesh carborundum, bean plants, tomato plants.

PROCEDURE:

Grind several potato "eyes" in 5 ml. of water and add ½ g. of carborundum. Brush on a leaf of a bean plant and on a leaf of a tomato plant. Repeat the procedure using: (1) 1 g. dried tobacco leaf in 5 ml. of water plus ½ g. carborundum. (2) Several potato "eyes" ground with 1 g. dried tobacco leaf in 5 ml. of water plus ½ g. carborundum.

Make daily observations and record them.

HYPOTHESIS:

1. Indicate what you think may have occurred.
2. What evidence do you have to support your statements?
3. How could you further test your results?

EXERCISE 6. THE RATES OF FALL OF AIR-BORNE SEEDS. TO COMPARE THE RATES OF FALL OF SEVERAL KINDS OF AIR-BORNE SEEDS.

MATERIALS:

Stopwatches, seeds of various species, meter stick.

PROCEDURE:

1. Select several seeds of the same species.
2. Launch single seeds in a consistent manner and measure times of fall through a given distance.
3. Average the times of fall for one species.
4. Repeat 1, 2, and 3 with other species.

CONCLUSIONS: Write out your own conclusions.

QUESTIONS:

1. What influence does the rate of fall have upon seed dispersal?
2. Why do seeds fall at different rates?
3. What other factors do you think would affect seed dispersal?

EXERCISE 7. THE STATISTICAL APPROACH TO A LABORATORY PROBLEM.

Waste waters from local copper smelters or other sources of possible pollution have toxic effects on pond snails as established by past experiments. These data could be further explored in relation to concentrations and limits which would support life.

Obtain samples of pond water; introduce varying concentrations of waste liquids, and place in jars with snails, setting up several as controls.

Use water cress as snail food and aerate all of the containers. Examine all of them at given intervals. Note the results in the controls and in the experimental jars, and record.

Interpret the data obtained by applying the T test for the significance of the experiment. There should be a minimum of 10 tests in each case. The equation is solved and then the T values plotted to show significance.

$$T = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{Sx_1^2 + Sx_2^2}}$$

T — Level of significance (must be above 2.5 to be of significance)
x_1 — Control (all)
x_2 — Experimental (all)
Sx_1 — Sum of variance
Sx_2 — Sum of variance

Variance is found by adding differences from average of all results. (Do for both control and experimental results.)

(Note: Too high or low value will show results are not valid.)

EXERCISE 8. A STUDY OF THE EFFECTS OF ELECTRIC SHOCK ON INSECT FORMS THAT LIVE BELOW THE SURFACE OF THE SOIL. TO DEVELOP A CONTROL OF SUB-SURFACE DWELLING FORMS OF INSECT PESTS.

MATERIALS:

1. Steel rod.
2. Transformer.
3. 50′ or 100′ of electric cord with switch device. Connect the electric cord to one end of the steel rod. Tape this connection rather heavily. Put a plug on the other end of the electric cord —connect only one wire to the plug. (If no current goes through the rod, reverse the insertion of the plug in the outlet—a check on the flow of the current can be made by sticking the probe in the ground, then putting the plug in the outlet—earthworms will come to the surface in one minute if the power is on.)

PROCEDURE:

Choose an area of ground within reach of an electric outlet. Probe the ground—check insect life, if any, that comes to surface—dig up and examine other insect specimens.

Increase voltage as much as necessary within the limitations of the transformer.

EXERCISE 9. CAN LIGHT BE USED TO GUIDE FISH?

MATERIAL:

Aquarium, maze constructed of sponge material, black paper, light sources, bulbs of different intensities, small aquarium fish, i.e. tropicals, salmon, or trout as may be obtained from state hatcheries.

PROCEDURE:

Place maze between fish and light source. Use black paper to shut out unmeasured light. Vary light intensity by use of bulbs. Locate maze at different places and angles and in correlation with light intensities establish the effect of light and the behavior of fish.

CONCLUSIONS:

Record findings:

a. Position of maze and behavior.
b. Intensity of light and behavior.

QUESTIONS FOR DISCUSSION IN CLASS:

1. Is it theoretically possible to guide fish down stream by light?
2. Can light be used at dams to guide fish upstream and/or down?
3. Interpret fish habits at night.
4. Is it lawful in your state to build a bonfire at the river's edge or fish by flash light?
5. Establish reasons why artificial light and night fishing may be unsportsmanlike.

EXERCISE 10. A PROJECT IN SAMPLE TESTING: 1) TO DETERMINE THE SIZE OF A SAMPLE REQUIRED TO PREDICT THE VARIATION IN A TOTAL POPULATION; 2) TO GAIN EXPERIENCE IN APPLYING THE SAMPLING TECHNIQUE TO THE MEASUREMENT OF VARIABLES IN A TOTAL POPULATION.

MATERIAL:

Tape measures, a hat-size scale, cross-section paper, pencil, and writing paper.

PROCEDURE:

Select from your class four teams of 3 or 4 students each. Each team will then take convenient stations at the school entrance(s) before school (or after, or at noon, or between classes) and as quickly and with as little confusion as possible, measure 20 pupils for head size.

Care must be exercised that there be no other than strictly random selection. Measure each head quickly, but accurately to the nearest ⅛″, and record; names should not be recorded.

After the samples are taken, let each group draw a line or bar graph showing the frequency distribution of the head-sizes recorded. From these data let each group predict the size distribution to be ordered for the entire school.

Compare the distributions and predictions of each group before the class. Then, COMBINING the data from ALL 4 samples, prepare another frequency distribution graph (or curve) and determine what this information, considered as a single sample, indicates as to cap sizes to be ordered, and in what quantity.

QUESTIONS:

1. Test some factors you think might influence positively or negatively your sample.
2. Which of these factors or variables could you control or eliminate?
3. From your experiment or data, what are your conclusions as to the "average" of the entire population, in terms of your sample?
4. Is "average" an accurate way of describing a population?

EXERCISE 11. DO DIFFERENT ISOTOPES OF THE SAME ELEMENT POSSESS THE SAME CHEMICAL PROPERTIES?

A student wishes to conduct a nutritional experiment involving the metabolism of iodine by white rats. Using radioactive iodine and tracer techniques, part of the reliability of the conclusions depends upon the metabolism of radioactive and non-radioactive iodine being the same.

Using a "hot" potassium iodide solution in standard chemical test reactions for iodine and ordinary potassium iodide solution as a control in the same reactions, the student should be able to show that chemical reactions for radioisotopes are the same as those for the normal isotope of the same element.

REFERENCE:

Laboratory Experiments with Radioisotopes for High School Science Demonstrations, Superintendent of Documents, Washington 25, D. C. Price: 30 cents.

EXERCISE 12. DO PLANTS AND ANIMALS ABSORB RADIOACTIVITY FROM WATER?

Waste water from the atomic reactors at Hanford, Washington, is discharged into the Columbia River. The Atomic Energy Commission periodically samples and examines fish and plants from the river for signs of radioactivity.

By placing goldfish or other aquatic life in water made radioactive with phosphorus ($Na_3P^{32}O_4$), one can later dissect the goldfish and locate areas of radioactivity with a Geiger counter or by exposure to X-ray film. P^{32} is available for high school laboratory experiments in ten-microcurie lots.

REFERENCE:

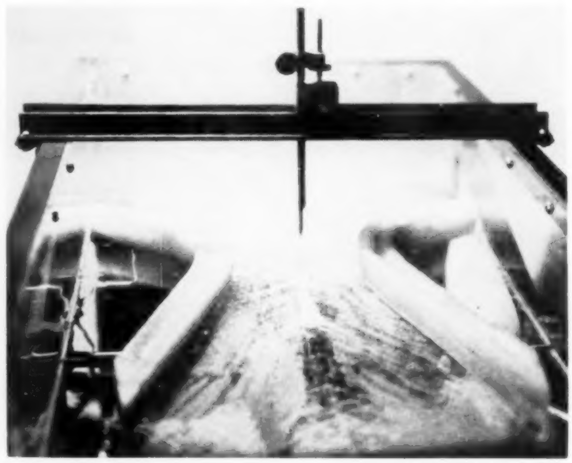
Laboratory Experiments with Radioisotopes for High School Science Demonstrations, Superintendent of Documents, Washington 25, D. C. Price: 30 cents.

This exercise lends itself to a cooperative teamwork approach. Biology students can do the dissection, chemistry students the photography, and the Geiger counter can be handled by physics students.

Another similar experiment which lends itself to the same type of cooperative teamwork involves the use of radioactive iodine. A rat fed on a glucose and water diet for several days is given a diet containing radioactive iodine. By use of a Geiger counter, and also by preparing a radioautograph, the group can see in what part of the rat's body the tagged iodine is concentrated and try to determine why.

EXERCISE 13. A WATER TABLE TO BRING SUPER-SONIC PHENOMENA TO THE SCIENCE CLASSROOM.

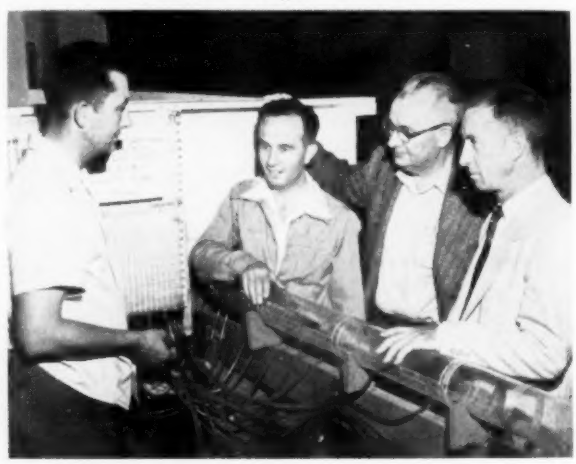
A device, well-known in some college laboratories, which will bring the realm of super-sonic speeds into the classroom may be of some interest to science teachers. This device, called a water table, is a rectangular box open at the top and ends with sides and bottom constructed of flat, clear plastic. The plastic material insures adequate illumination but is not essential for the water table. The pitch and level of this plastic box should be adjustable. An inlet reservoir at one end and an outlet tank at the other are arranged so that a continuous sheet of water approximately ¼" thick will flow smoothly over the bottom of the plastic box.



A water table to bring super-sonic phenomena to the science classroom.

Air flow forms of all types may now be inserted in the flowing sheet of water for the study of the flow past various shapes. Though the water is flowing relatively slowly, its great density, compared

Water flow through a model culvert.



A hydraulic model.

to air, sets up flow conditions which are comparable to speeds up to Mach Number 2.5 or 3 in air. Shock waves are easily shown, and the pulse of the shock waves as the speed of sound (relatively) is reached and passed is strikingly demonstrated. This water table duplicates conditions of sonic speeds which usually take expensive windtunnels to demonstrate.

EXERCISE 14. PROJECT IN EXTRACTION OF ESSENTIAL OILS.

The task of determining the optimum conditions under which a process might operate suggests itself as a possible student project. The field distillation of peppermint oil from peppermint hay suggested a rather broad range of experiments. There could be specialization in determining just exactly what physical conditions and processes result in the maximum yield of a particular extraction process. Some of the variables that might be investigated are as follows: Should the raw material be in its natural form, or chopped up? Should the raw material be subjected to steam distillation, or should it be immersed in boiling water? What temperature ranges produce the best separation of the essential oil from the water? What mechanical arrangement of inlets and outlets and baffles is best? All these questions (problems) could be determined for the one particular extraction process that might be possible with the raw materials that might be available in a particular locality.

A broader problem to attack might be widespread sampling of the essential oils that might be available from a variety of local plants, with the extraction, separation, purification, and determination of the nature and possible use of the oils as a long-range project. Some of the folk-lore brews may provide leads for worthy investigations into some of the claims made.

EXERCISE 15. COMPARING SOIL IMPROVEMENT PREPARATIONS.

It is known that minute amounts of elements in the soil make great differences in the growing properties of any soil. In many areas the addition makes noticeable differences in plant growth, and in others, very little. How does the soil in your area rate in this capacity?

Two very useful materials containing trace minerals are pulp wastes from paper mills and commercial trace elements from a garden store. Which is superior in your area?

One way to find out is to take three shallow boxes and fill each with the same soil up to about four inches deep. If you live in an area where things grow all winter, you may mark off about three square yards and mark each with stakes driven into the ground and tie strings around the stakes.

To one sprinkle trace element minerals according to the directions given on the package; mix uniformly with a rake. In the middle box or plot leave the soil as it was. To the third add the same amount of pulp waste as you did trace elements and again rake uniformly.

Plant some radish or other quick growing plants according to directions in each of the plots. Water with sprinkler uniformly. Keep a chart on each plot as to when sprouted, how rapidly each grows, and when mature check each plot for size, taste, quality, and uniformity. Check your soil for trace elements to see which seems best for your soil, if any. (*Note: This type of experiment requires adequate replication.*)

EXERCISE 16. THE WEATHERING EFFECT ON PAINTED SURFACES.

This project should be given at the beginning of the school year so that the students can see the effects of weathering before school is out in the spring.

The white pigments used in making paint are white lead, zinc white, lithopone, and titanium white. Make up four different prime coats using each pigment containing two parts pigment, one part linseed oil, and one part turpentine. Make up the four finish coats containing one part pigment and one part linseed oil.

Obtain several different samples of outside paint, both prime coat and finish coat, made by different manufacturers.

Cut test panels ½" x 4" x 8" from old seasoned wood. (New wood requires a second coat containing two parts pigment, one part linseed oil, and one part turpentine before the finish coat.) To each

panel apply the prime coat and let dry for three days. Be sure to label panels for identification purposes. Apply the finish coat and let it dry for three days. Place the test panels on the roof of the building to weather.

Several similar projects of this kind using varnishes, sealers, and different paint mixtures could be used. Test panels started this year can be observed by the class next year and new test panels started.

A weatherometer for speeding up weathering effects can be constructed. This consists of a rotating cylindrical container about two feet in diameter to which your test panels can be attached. Water is sprayed on the panels at intervals, heat is applied by a heat lamp, and an ultraviolet light is used to give the effect of rays from the sun. Properly constructed, it will speed up weathering about six times.

EXERCISE 17. SAMPLE OF A POSSIBLE HIGH SCHOOL EXERCISE IN PERCEPTION, USING THE SENSE OF TASTE.

SOME SAMPLE QUESTIONS THAT MAY BE DEVISED:

1. Do our tastes vary from person to person?
2. Do our tastes vary with change in our surroundings?
3. Do our tastes vary with the time of day?

HOW THEY MAY BE APPLIED:

This is a simple application of the taste test of the Oregon State College Food Technology Department, using two commercial brands of vegetable cocktail juice. A sample of each is placed in paper cups and marked by letter only. In class groups, each person tastes his samples and fills his comparison sheet.

1. Comparison sheet.
2. A closet or small room is arranged so that each person in the class may make another comparison test on the same liquids without the presence of his classmates.
3. After school is dismissed the class returns for a few minutes to repeat step one.

   Results are tabulated the next day with the help of the class.

CONCLUSIONS:

Derive from the results—one may well be that there is NO RIGHT answer—perceptions vary.

EXERCISE 18. SUGGESTED PROBLEM FOR EARTH SCIENCE OR GENERAL SCIENCE CLASSES, JUNIOR OR SENIOR HIGH SCHOOL LEVEL.

To be used after the study of glaciers, icebergs, lake formation, climate changes, and exposition of rocks and soils.

PROBLEM:

To explain how granite boulders (erratics) got into the Willamette Valley in Northwestern Oregon.

FACTS AS ASCERTAINED BY GEOLOGISTS:

1. There is no granite of this type found naturally closer than Northern Idaho or Southern Canada.
2. These boulders are mostly rounded showing the effect of stream erosion, and the surfaces are hard, showing no prolonged weathering.
3. In some cases they show definite striae (scratches and grooves from ice polishing).
4. This area of Northwestern Oregon was never glaciated.
5. The boulders are found at an elevation of 400 feet or lower and at higher elevations along the Columbia Valley until an elevation of about 1700 feet is reached.
6. The boulders vary in size from pebbles to those weighing many tons.
7. They are found near the top of the present mantle rock and are exposed naturally through the soil.

Above are the facts. How do you think these boulders got there? (The best solution seems to be that during the Ice Age the Columbia River was dammed into a series of lakes starting with the Williamette Valley and extending back to the Canadian border. Glacier fronts broke off into icebergs and floated down this chain of lakes dropping the boulders where they melted, usually where the icebergs grounded along the border of the lake.)

The group feels that this suggested exercise is of general enough interest to be made use of by any science teacher wherever located. We would like to suggest, however, that almost any observant science teacher can find local phenomena of a like nature which will stimulate students to think.

One teacher from Nevada used the moving boulders of the mud flats of the west and southwest. Another, the granite peaks surrounded by the lava flows of Idaho, and still another used the occurrence of the quartz deposits (chert) in the sedimentary rocks of the Berkeley Hills of California as an example of a city teacher's use of local situations.

"Distance may lend enchantment" but there is still no substitute for taste, touch, see, and smell.

EXERCISE 19. HOW MUCH SEED SHOULD A FARMER PLANT PER ACRE?

INFORMATION NEEDED:

Established seeding practice; purity and variability of seed available.

PROCEDURE:

Examine samples of seed available to determine the amount of foreign matter present. Observe the number of injured and substandard seed and calculate their percentage. Run a laboratory germination test to determine the number and percentage of good seeds.

CONCLUSION:

Determine the actual amount of seed of the given sample that must be planted per acre to obtain the usual spacing between plants.

EXERCISE 20. USING THE RESEARCH APPROACH IN ESTABLISHING CERTAIN BIOLOGICAL CONCEPTS.

PROCEDURE:

Instead of first telling a group some facts about a plant or animal, the students are sent out to collect abundant numbers of a species found in the vicinity of the school. This may mean a collection of frogs, fish, insects, reptiles, or what have you.

Meanwhile the group sets up a number of questions that are to be answered by an examination of the particular species collected. The choice of questions depends on the species and the gross examination of internal and external features of the animal or plant.

The effort should be made to not consult the text in finding the facts. Choice of animal or plant depends entirely upon those found in large number.

EXERCISE 21. HOW ARE THE PROPERTIES OF MATERIALS CHANGED BY FREEZING?

INFORMATION:

Solid "dry ice" changes directly to gaseous carbon dioxide at any temperature above —78° C. (—110° F.). This low temperature can be used to freeze many materials. The cooling process is best promoted by using the dry ice in acetone.

PROCEDURE:

Freeze and observe the properties of each of the following: rubber ball, flower or leaf, a strip of solder, mercury, water, a piece of aluminum or zinc.

EXERCISE 22. DOES QUICK FREEZING AFFECT THE CELLS OF PLANT TISSUES?

INFORMATION:

Solid "dry ice" changes directly to gaseous carbon dioxide at any temperature above —78° C. (—110° F.). This low temperature can be used to freeze many materials. The cooling process is best promoted by using the dry ice in acetone.

PROCEDURE:

Obtain samples of various types of plant or animal tissues in which the cells can be seen with the microscope. Examine in detail under the microscope to see the form of the cells. Then dip the material into the cold acetone long enough for it to become frozen. Examine immediately under the microscope and note any changes in the cells. Compare with the original cells or with other material which is frozen more slowly in a refrigerator.

EXERCISE 23. ARE VEGETABLE DYES PURE SUBSTANCES OR ARE THEY MIXTURES OF DIFFERENT DYES?

Chromatography methods of analysis are explained in *Journal of Chemical Education*, July 1953, page 370. See also *The Science Teacher*, October 1951, page 196.

EXERCISE 24. COULD THE NINHYDRIN INDICATOR (TURNS COLOR WITH PROTEINS) BE USED IN PLACE OF BIURET AND XANTHROPROTEIC TESTS FOR A PROTEIN IN EXPERIMENTS IN HIGH SCHOOL?

REFERENCE:

Paper Chromatography, R. J. Block, R. L. Strange, and Gunter Zweig, Academic Press Inc., 1952. New York, N. Y.

EXERCISE 25. CAN YOU DETERMINE WHICH ELEMENT IN A RADIOACTIVE COMPOUND IS RESPONSIBLE FOR THE RADIATION?

REFERENCE:

Laboratory Experiments with Radioactive Isotopes, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price: 30 cents.

EXERCISE 26. SUGGESTIONS TO ILLUSTRATE THE NECESSITY OF CLEANLINESS.

PROCEDURE:

1. Have students cough into a pure culture of bacteria. Note and record contamination.
2. Put finger print on mirror lens or slide, and note effects upon microscope technique.
3. Have a student who smokes finger leaves of tomato or bean plants susceptible to tobacco mosaic virus. Observe.

EXERCISE 27. TO DETERMINE WHICH ACIDS ARE CONTAINED IN ORANGE JUICE.

PURPOSE:

The relatively new technique of paper chromatography can be adapted to secondary school analysis of inorganic as well as organic compounds. The purpose of this paper is to show a method of using this technique in the analysis of citric and malic acids in orange juice. It is felt that with this background, an industrious student could go ahead on more advanced research into other components contained in this and other materials.

METHOD:

A method suggested by Dr. C. H. Wang of Oregon State College is given as follows:

An old-fashioned vacuum desiccator is obtained with the top of the lid removed. A petri or crystallizing dish is placed in the bottom to hold the saturating solvent. A separatory funnel containing the same solvent is connected by means of neoprene tubing to a piece of capillary tubing drawn at the free end. A screw-type pinch clamp is fastened on the neoprene tubing to regulate the flow of the solvent. Whatman number 1 filter paper larger in diameter than the outside flange diameter of the desiccator is processed as described in the next paragraph and, with wick attached, is placed across the dessicator as shown in Figure 1.

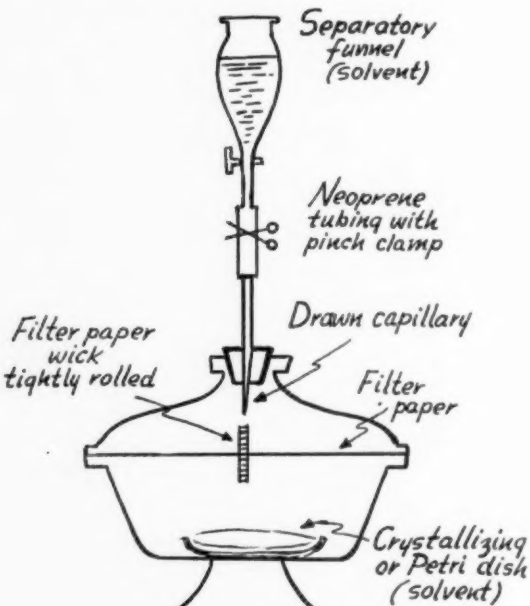


Figure 1

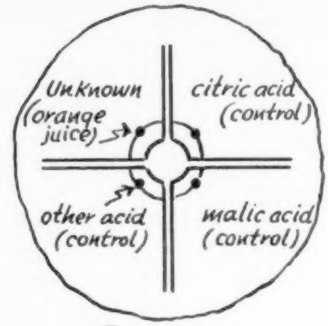


Figure 2

Whatman No. 1 filter paper 24 cm. or larger with 3 x 5 cm. filter paper wick tightly rolled.

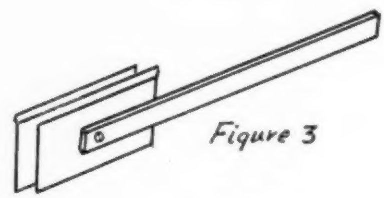


Figure 3

Two single-edge razor blades separated by extra nut between blades, fastened to strip of metal.

The large circular filter paper is divided into four or eight parts, as is shown in Figure 2. DO NOT FOLD and do not touch with the fingers anymore than necessary. (Why these precautions?) Two circles are drawn about the absolute center of the paper and slits are cut, by the razor blades shown in Figure 3, from *near the outside edge of the filter paper* to the inner circle. The unknown and control acids are applied to a marked spot on the second circle. These spots should be kept as small as possible by application with a drawn capillary tube and allowing each spot to dry before the next one is applied in the same place. The number of times the spot is applied is called the level of the compound. The level will vary with the compound and will have to be determined by experimentation. After the "spots" have been applied, a wick consisting of a 3 x 5 cm. piece of filter paper rolled tightly is inserted in a small hole at the absolute center of the circular filter paper. When this is done, the large filter is ready to be placed in the desiccator.

During the time the filter paper is being prepared, the desiccator should be closed so that the solvent in the crystallizing dish can saturate the atmosphere. After the filter paper is placed in the desiccator allow the solvent from the separatory funnel to drop through the capillary tube onto the wick at a very slow rate. The solvent

should drip very slowly from the bottom of the wick into the crystallizing dish. After 3 hours the solvent front should have advanced nearly to the edge of the desiccator. Remove the filter from the desiccator and dry with warm air. The filter should then be steamed and dried twice to remove any acetic acid. Bromphenol blue 0.1% contained in a nose sprayer or other bulb aspirator is applied lightly to the surface and the filter is allowed to dry in warm air.

After the experiment is completed the paper will look somewhat like the diagram in Figure 4.

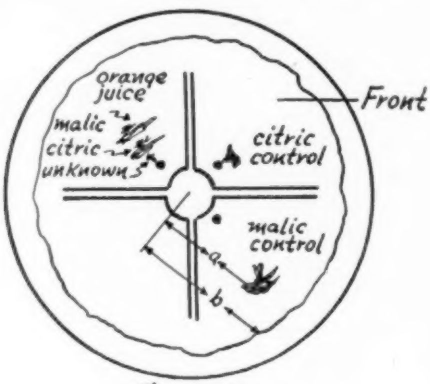


Figure 4

It is noted that the orange juice is shown to contain both citric and malic acids since two of the chromatograms are shown the same distances from the center of the filter as the control acids. Note the portion which has been labeled as unknown. Further experimentation could be done here. The ratio a/b is called the RF factor for that compound.

THE TECHNIQUE ILLUSTRATED COULD HAVE MANY APPLICATIONS:

1. The analysis of other unknowns such as apple juice, grapefruit juice, lemon juice, etc.
2. Do frozen, canned, and fresh orange juice contain the same compounds?
3. Can the presence or absence of certain compounds in orange juice be correlated with taste preferences?
4. Can the "fresh" taste of orange juice be restored by adding certain compounds?

Experimentation with the apparatus and techniques suggested by Dr. Wang has produced excellent results. The following list contains recommended solutions, solvents, and indicators and concentrations of each. Other solvents, indicators, and solutions can be obtained from the numerous references on this subject.

SOLUTIONS:

Sugars		*Amino Acids*	
1. Glucose	2%	1. Aspartic Acid	5mg./ml.
2. Fructose	2%	2. Glutamic Acid	5mg./ml.
3. Lactose	2%	3. Cystine	5mg./ml.
4. Sucrose	2%	4. Glycine	5mg./ml.
5. Maltose	2%	5. Leucine	5mg./ml.
6. Galactose	2%	6. Histidine	5mg./ml.
7. Mannose	2%		
8. Xylose	2%		

Organic Acids	
1. Citric Acid	10mg./ml.
2. Malic Acid	5mg./ml.
3. Oxalic Acid	5mg./ml.
4. Tartaric Acid	5mg./ml.

INDICATORS:

1. Sugars—Ammonical Silver Nitrate—(Do not allow to dry, fulminate is formed.)
2. Amino acids—Ninhydrin in butanol saturated with water.
3. Organic acids—0.1% Bromphenol blue—steam chromatograph first to dissolve acetic acid.

Solvent: Butanol, acetic acid saturated with water (5-1-4).

◆ ◆ ◆

The Future Scientists of America Foundation is under the direct administrative guidance of the following people: DR. HENRY H. ARMSBY, Chief for Engineering Education, U. S. Office of Education, Washington, D. C.; DR. L. EARLE ARNOW, Vice President, Sharp and Dohme, Philadelphia, Pennsylvania; MR. ROBERT H. CARLETON, Executive Secretary, National Science Teachers Association, Washington, D. C.; DR. PHILIP G. JOHNSON, *Chairman,* Professor of Science Education, Cornell University, Ithaca, New York; DR. MILTON O. LEE, Secretary-Treasurer, Federation of American Societies for Experimental Biology, Washington, D. C.; DR. WALTER S. LAPP, Chairman of the Science Department, Overbrook High School, Philadelphia, Pennsylvania; PROF. RALPH W. LEFLER, Assistant Professor of Physics and Education, Purdue University, Lafayette, Indiana; DR. JOHN S. RICHARDSON, Professor of Education, Ohio State University, Columbus, Ohio; DR. ROBERT STOLLBERG, Associate Professor of Science and Education, San Francisco State College, California. Prior to July 1, 1954, DR. ALLEN V. ASTIN, Director, National Bureau of Standards, Washington, D. C., and DR. CHARLOTTE L. GRANT, Teacher of Biology and Dean of Junior

Class, Oak Park and River Forest High School were members of the Administrative Committee.

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To insure professional status and adequate coordination with the total educational profession, all plans for the 1954 West Coast Conference were submitted for review by an Advisory Committee composed of: DR. FRANCIS BROWN, American Council on Education; DR. NORMAN R. SHEPARD, Engineering Manpower Commission of Engineers Joint Council; DR. GEORGE W. DENEMARK, Association for Supervision and Curriculum Development (NEA); DR. PAUL E. ELICKER, National Association of Secondary School Principals (NEA); DR. EDGAR FULLER, National Council of Chief State School Officers; DR. GALEN JONES, U. S. Office of Education; DR. MORRIS MEISTER, AAAS Cooperative Committee on the Teaching of Science and Mathematics; and DR. HOWARD A. MEYERHOFF, Scientific Manpower Commission.

To provide a wider base from which plans could originate, be evaluated, and eventually put into action, a Development Committee was appointed. The members were: MR. JOHN A. BEHNKE, American Association for the Advancement of Science; DR. CHARLES B. HUNT, American Geological Institute; DR. FRANCIS W. SEARS, American Institute of Physics; DR. B. R. STANERSON, American Chemical Society; and MRS. ILEEN B. STEWART, American Institute for the Biological Sciences.

The co-directors of the conference were MR. STANLEY E. WILLIAMSON, Associate Professor of Science and Education, Oregon State College, and DR. JOHN H. WOODBURN, Assistant Executive Secretary, National Science Teachers Association.

During the early stages of planning the conference, valuable help was obtained from trial interviews with the following people: Mr. B. P. Martinez, Chief, Stream Pollution Research Section, Bureau of Mines, U. S. Department of Interior, College Park, Maryland; Dr. Hugh G. Gauch, Professor of Plant Physiology, University of Maryland, College Park, Maryland; and Dr. Milton Harris, President and Director of Research, Harris Research Laboratory, Washington, D. C.

Participants in the 1954 Crown Zellerbach West Coast Science Teachers Summer Conference were: Louis B. Alcorta, Abraham Lincoln Senior High School, San Francisco, California; Lee R. Armstrong, J. V. Weatherwax High School, Aberdeen, Washington; Myrl R. Barkhurst, Myrtle Creek High School, Oregon; Charles O. Blodgett, San Luis Obispo High School and Junior College, California; Ted B. Bowen, Ellensburg High School, Washington; Francis D. Calhoon, Berkeley High School, California; Moulton G. Clark, Kennewick High School, Washington; Alpha H. Fifer, Carson Elementary School, Carson City, Nevada; Jack Fishleder, Wickenburg High School, Arizona; Gretchen B. George, Newberg Union High School, Newberg, Oregon; Robert K. Henrich, Columbia High School, Richland, Washington; Gladys B. Herron, Klamath Union High School, Klamath Falls, Oregon; Howard E. Hickcox, Lebanon High School, Oregon; William H. Hudson, J. A. O'Connell Technical Institute, San Francisco, California; Virginia F. Kent, Edmond S. Meany Junior High School, Seattle, Washington; Don C. Lillywhite, Mesa High School, Arizona; John H. Marean, Reno High School, Nevada; Howard I. Monks, Marshfield High School, Coos Bay, Oregon; Martin Mortensen, Arizona State College, Tempe; Clyde F. Powell, Santa Ana High School, California; Eugene Roberts, Curriculum Laboratory, San Francisco Public Schools, California; James T. Robinson, El Rancho High School, Rivera, California; Dwight K. Runner, Raymond High School, Washington; George S. Scott, Grangeville High School, Idaho; Neil W. Sherman, Phoenix Elementary Schools, Arizona; Paul Stoner, Mt. Diablo High School, Concord, California; Clarence W. Strong, Springfield High School, Oregon; Robert S. Strong, Grandview High School, Washington; Genevieve M. Swick, Eureka County High School, Nevada; Richard F. Thaw, Corvallis High School, Oregon; Leslie J. Weigart, Grants Pass High School, Oregon; Robert C. Whitney, Bellevue High School, Washington; Stanley E. Williamson, *Co-director,* Oregon State College, Corvallis; John H. Woodburn, *Co-director,* National Science Teachers Association, Washington, D. C.

How to Insure a Successful BLOOD SLIDE Demonstration

By **FRANK E. WOLF**
Fulbright Science Teacher, Bassein, Burma

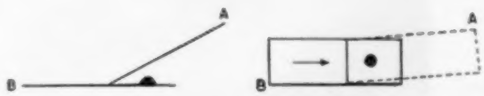
HAVE you ever followed high school laboratory manual directions for making blood slides and been dissatisfied with the results? Upon examining several high school laboratory manuals, it became apparent why teachers in the United States as well as Burma may be unable to identify blood cells on slides made according to some laboratory manual directions. First of all, the usual slide-making technique of putting a drop of water on the slide is absolutely to be avoided in making blood slides because water hemolyzes the red blood cells. Second, the usual method given in these manuals for examining blood is most unsatisfactory; i.e., an unstained slide under high power will reveal very little to the untrained observer. The slide should be stained and if possible examined under the oil immersion 1.8 mm objective. It is true that blood cells may be seen under the high dry objective in an unstained preparation; however, differentiation of cells will not be possible to a satisfying degree to most children and teachers. Third, slides must be scrupulously cleaned and dried, and free from fingerprints.

Following are the procedures for making a good blood smear, staining the smear, identifying the various kinds of blood cells, and counting the cells.

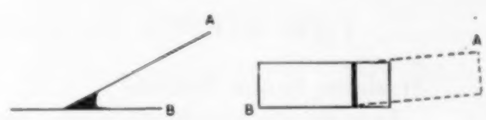
I. Making a blood smear

A. Procedure

1. Sterilize a needle.
2. Wipe an index finger with an alcohol sponge; dry finger thoroughly.
3. Make a small puncture with the needle.
4. Disregard the first drop of blood and place the second drop near the edge of a clean dry slide (held at the edges to prevent fingerprints).
5. Place the alcohol sponge on the finger wound.
6. Take a new slide ("puller slide") with an intact edge and place at a thirty degree angle on the first slide ("preparation slide").



7. Bring the "puller slide" back to the drop of blood until the blood flows the length of the short edge of the "puller slide" by capillary action.

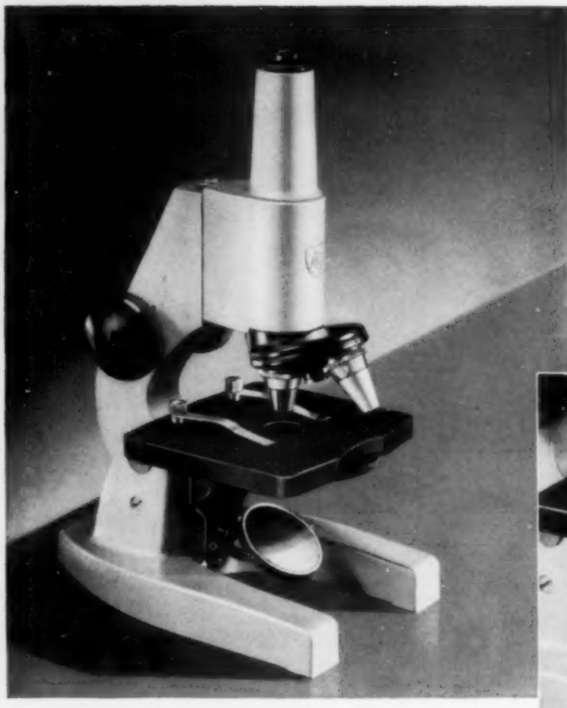


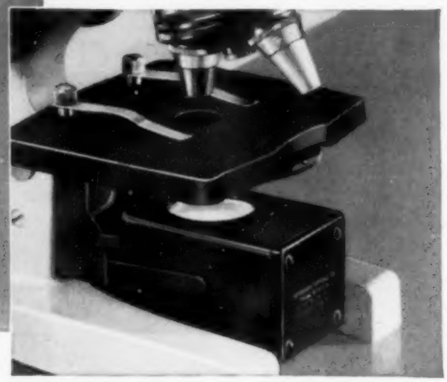
8. Push the "puller slide" the length of the "preparation slide" maintaining the angle at an even rapid stroke.

9. Allow to air dry and protect from flies.
10. Print identification on the thick end of the slide directly in the blood.

B. Precautions

1. Remove all traces of grease from new slides by cleaning in alcohol or soap and water.





2. Slides must be thoroughly dry.
3. Do not breathe on the slide to hasten the drying of blood as the breath may hemolyze the cells.

II. Staining the smear

A. Procedure

1. The slide is stained with Wright's Stain which may be bought ready for use from most drug houses or drug stores. It may also be made by the class.[1]
The best procedure is to borrow a small quantity of stain from a hospital or private laboratory.
2. Having obtained a small quantity of Wright's Stain (one-half ounce or so), disregard the standard directions for the use of a prepared buffer solution as this may require a cash outlay and will require practice to determine the optimal staining time. The writer has compared buffers, over a wide range of pH, against neutral distilled water and has found along with co-workers that the neutral distilled water gives satisfactory results.
3. Cover the entire slide with Wright's Stain for the number of minutes recommended by the source of supply.
4. If evaporation takes place, add more stain.
5. After the prescribed number of minutes, slowly add the distilled water while blowing on the slide to mix the stain and distilled water until an equal amount of distilled water has been added to the stain. A greenish metallic coating will be formed on the surface of the stain when the correct proportions have been reached. Add more stain if an excess of water was added.
6. Allow the preparation to stand approximately twice as long as the timing for the stain alone.
7. Flush the slide with water, taking care to float off the greenish coating and using an adequate quantity of water to remove the surplus stain.
8. Dry the bottom surface of the slide with with a paper towel or cloth.
9. Air dry the top of the slide.

[1] Procedures for making Wright's Stain may be found in: Kolmer and Boerner, *Approved Laboratory Techniques*, D. Appleton-Century Company; Todd, James C., and Arthur Sanford, *Clinical Diagnosis by Laboratory Methods*, W. B. Saunders Company.

B. Precautions

1. The surface of the slide containing the blood must be up to receive the stain.
2. Do not run the stain or distilled water over the edge of the slide prior to flushing.
3. The transferring glassware must be clean and dry.
4. Do not blot slide; you may lose the preparation and/or add lint which will obscure the cells.

III. Identifying the cells[2]

(Use high dry or oil immersion objective.)

All of the following identifying characteristics are for normal cells and a wide variation in these characteristics may be observed.

A. The erythrocytes (red blood cells)

1. Normal red blood cells are non-nucleated, non-granular cells appearing as biconcave discs.
2. The less intensively stained centers give the cells the appearance of doughnuts. These cells are a pinkish red.
3. The cytoplasm is homogeneous.
4. These cells are seven to nine microns in diameter.
5. These will be the most numerous of all the cells on the slide.

B. The leucocytes (white blood cells)

1. Granulocytes

a. polymorphonuclear neutrophils[3]

1) irregular nuclei usually with two to five lobes.
2) nuclei stain deep purplish blue
3) cytoplasm stains pale pink or violet
4) ten to fifteen microns in diameter
5) most numerous of the white blood cells

b. polymorphonuclear eosinophils

1) irregular nuclei usually with two to three lobes
2) nuclei stain pale purplish blue

[2] Details in this section such as size and percents are modified from: *Methods for Laboratory Technicians*, T.M. 8-227, War Department Technical Manual; U. S. Government Printing Office, 1947.

[3] Children often enjoy the full name neutrophilic-polymorphonuclear leucocyte.

3) cytoplasmic granules are large and stained deep red
4) ten to fifteen microns in diameter
5) one to six percent

c. polymorphonuclear basophils

1) irregular nuclei usually with two to three lobes
2) nuclei stain pale purplish blue
3) cytoplasmic granules are large and stained deep bluish black
4) ten to fifteen microns in diameter
5) least numerous of the white blood cells

2. Agranulocytes

a. lymphocytes

1) nuclei not lobed but may be indented
2) deep purplish blue nucleus nearly fills the cell
3) cytoplasm pale blue to pale pink
4) seven to eighteen microns in diameter
5) approximately half the number of the neutrophils

b. monocytes

1) nucleus round, indented, or horseshoe shaped and turned over on itself
2) nucleus pale bluish violet
3) cytoplasm pale blue or lavender with darker granules
4) twelve to twenty microns in diameter
5) approximately four to eight percent

C. Platelets

1. Platelets are round or oval bluish bodies.
2. Platelets may occur singly or in clumps.
3. It is better to identify clumps as precipitated stain may be mistaken for single platelets.
4. Platelets are one to two microns in diameter.
5. There are approximately one-tenth as many platelets as red blood cells.

IV. Counting the cells

A. Procedure

Count one hundred white blood cells keeping a record of the number of each of the five main kinds of white blood cells, i.e., neutrophils, eosinophils, basophils, monocytes, and lymphocytes. The number of each becomes then a percent of the total number.

B. Precautions

Be sure to cover a wide area of the slide in order to get a representative count. It may be necessary to count two hundred cells before a basophil is seen. Above all do not make any inferences concerning deviations from the normal cell count unless qualified to do so.

NOMINEES FOR OFFICERS AND DIRECTORS, 1955

Following established practice, this year's nominating committee has prepared a slate of candidates from among persons suggested by NSTA members, affiliated groups, and officers and leaders of the Association. The committee selected these nominees in an all-day meeting held in Washington, D. C. last December 11. Members of the committee are Zachariah Subarsky, *chairman,* New York City; Paul Blackwood, Washington, D. C.; Mrs. M. Gordon Brown, Atlanta, Georgia; John B. Chase, Jr., Charlottesville, Virginia; Herbert Reichard, Allentown, Pennsylvania; and Maitland P. Simmons, Irvington, New Jersey.

Herewith is biographical information about the nominees. The paragraphs present, in this order: name; present professional connection; degrees; experience; activities; honors and publications; other items.

Ballots are being mailed to all NSTA members. They should be marked and returned to the committee chairman, **Dr. Zachariah Subarsky, Bronx High School of Science Annex, 2400 Marion Street, Bronx 58, New York,** not later than March 12.

For President-Elect

JAMES G. HARLOW. Associate Professor of Education, University of Chicago. BA, MA (physics and math), University of Oklahoma; PhD (education), University of Chicago. Head, department of science, Northeast High School, Oklahoma City; Assistant Professor of Physics and Director, High School Science Service, University of Oklahoma; Dean, College of Arts and Sciences, University of Oklahoma; Commander, U. S. Naval Reserve. Served three-year term on NSTA Board of Directors; chairman and/or member of NSTA policy committee since its formation; served on several national-level conferences on manpower shortages in science and engineering; editor of *Proceedings*, Oklahoma Academy of Science, and member of its executive committee for several years. About 30 papers and articles in science and science education published in various journals.

JOHN S. RICHARDSON. Professor of Education, Ohio State University. BSEd, MA (chemistry), Miami (Ohio) University; PhD (education), Ohio State University. High school science teacher; Associate Professor of Education, Miami University; Visiting Professor of Education, Northwestern University and Rutgers University; science consultant to several Ohio public school systems. Currently serving second term as NSTA Treasurer; editor of *School Facilities for Science Instruction* (NSTA); chairman of NSTA Advisory Council on Industry-Science Teaching Relations; member administrative committee of NSTA's Future Scientists of America Foundation. Co-author of *Methods and Materials for Teaching General and Physical Science* (McGraw-Hill); author of many articles on science education; Phi Beta Kappa, Phi Delta Kappa.

For Secretary

KATHERINE M. HERTZKA. Biology teacher and chairman of science department, Hoke Smith High School, Atlanta. AB, Agnes Scott College; MS (biology), Emory University. Member NSTA committees on health science and biology; member, executive committee for Atlanta Science Congress. Awarded scholarship for summer study at Harvard (1952); Phi Beta Kappa, Delta Kappa Gamma.

DOROTHY TRYON. Chemistry teacher and chairman of science department, Redford High School, Detroit. BS, MS (chemistry), Wayne University. Served two terms on NSTA Board of Directors; currently serving as secretary; member committee for affiliated groups; past president Metropolitan Detroit Science Club; served as treasurer of Detroit Biology Club.

For Treasurer

HELEN E. HALE. Supervisor of Senior High School Science and Mathematics, Baltimore County Public Schools, Towson, Maryland. AB, Goucher College; MA, Johns Hopkins University. Formerly teacher of junior high science and mathematics and senior high physics. Member of NSTA research committee on school facilities for science instruction; chairman of operating committee for ASM-FSAF Science Achievement Awards for Students; regional director, Board of Directors, 1953-55; has served as secretary of Maryland Biology Teachers Association and of Delta Kappa Gamma.

RICHARD H. LAPE. Teacher of biology and head of science department, Amherst Central High School, Snyder, New York. BSEd, Buffalo State Teachers College; EdM, University of Buffalo. Teaching in present position since 1937; U. S. Air Force instructor in Meteorology; has served as instructor and lecturer in education, University of Buffalo; member of N. Y. State Regents Examination Committee in Biology; visiting consultant in education, Syracuse University. Has served as eastern vice-president of NSTA and as chairman of several committees; currently chairman of committee for biological sciences; member Advisory Council on Industry-Science Teaching Relations; regional chairman for ASM-FSAF Science Achievement Awards program of FSAF. Has published numerous articles in various science teaching journals; Phi Delta Kappa; New York State Science Teachers Association Fellowship Award.

For Director and Alternate Director, Region I (Two-year terms)

PHOTO BY BETH MURRAY

DOROTHY W. GIFFORD. Head, science department, Lincoln School, Providence, Rhode Island. AB, Mount Holyoke College; AM, Brown University. Formerly taught science in St. Mary's School, Peekskill, N. Y. Secretary of New England Association of Chemistry Teachers for six years; president, 1952-54. Member Rhode Island Schools Science Fair Committee; recipient (1953) of Brown University chapter of Sigma Xi award for outstanding science teaching. Has published articles in *Journal of Chemical Education*.

JOSEPH H. ROHLOFF. Head, science department, Aldrich High School, Warwick, Rhode Island. BS, MS, Missouri University. Participated in FSAF program for two years; Westinghouse Fellow at MIT, 1951; member first Oak Ridge Institute for Nuclear Studies conference for secondary teachers; recipient (1954) of Sigma Xi award for outstanding teaching. Serves as technical

director for a Providence, R. I., manufacturing concern. Author of *Bird's Eye View of Science.*

PHOTO BY WALTER R. FLEISCHER

FLETCHER G. WATSON. Associate Professor, Harvard Graduate School of Education. AB, Pomona College; MA, PhD, Harvard University. Formerly, Research Associate, Harvard Observatory and Technical Aide, National Defense Research Committee. Member NSTA committee on certification requirements for science teachers; member AAAS cooperative committee on teaching of science and mathematics. Elected to American Academy of Arts and Sciences (1953); Phi Beta Kappa, Sigma Xi, Phi Delta Kappa. Author of *Between the Planets* (Blakiston; revision now in press with Harvard University Press); numerous articles on astronomy and science teaching.

ROBERT K. WICKWARE. Professor of Education, Willimantic State Teachers College, Connecticut. BA (chemistry), University of Montana; MA, EdD, Teachers College, Columbia University. Formerly teacher of junior high science, Lewistown, Montana; assistant, TC, Columbia University; consultant in science education, Institute for Educational Leadership, University of Hiroshima and Tokyo University, Japan. Member NSTA committee on international relations and evaluation committee for Packet Service; member Connecticut state conservation education committee. Author of *Science Education* (Japan), three volumes, for Japanese Ministry of Education; many articles on science teaching and curricula.

For Director and Alternate Director, Region III
(Two-year terms)

CUSICK STUDIO

ESTHER L. BOSSUNG. Principal, F. T. Salisbury Elementary School, Louisville, Kentucky. BSEd, MS (biology), University of Louisville. Has taught as classroom teacher in Louisville Public Schools and served as instructor, University of Louisville. Author of *Source Book of Science Experiences for Elementary Schools*, Books I, II, and III. Delta Kappa Gamma.

PHOTO BY WALDEN S. FABRY

ROBERT T. LAGEMANN. Professor of Physics and Chairman, Department of Physics and Astronomy, Vanderbilt University. AB, Baldwin-Wallace College; MS, Vanderbilt University; PhD, Ohio State University. Formerly, instructor, Marshall College; Professor of Physics, Emory University; Research Physicist, Manhattan Project, Columbia University. Has worked actively with science fairs in Atlanta and Nashville; president (1951-52) Georgia Academy of Science. Has published three dozen articles in professional scientific journals; Sigma Xi, Sigma Pi Sigma.

HOWARD B. OWENS. Biology teacher, Northwestern High School, Hyattsville, Maryland. BSEc, Washington College; MS, University of Maryland. Formerly elementary science teacher at McDonogh School for Boys; biology teacher at Hyattsville High School; instructor in education, University of Maryland. Has served as chairman of NSTA committee on conservation; currently member of operating committee, Science Achievement Awards program and committee on extra-curricular activities; recipient of Washington Academy of Sciences award for distinguished service in science teaching and of Beaver Award from the Boy Scouts of America. Active in many educational and scientific societies; has served as research assistant at Maryland Agricultural Station each summer since 1943.

WALLER STUDIO

HENRY A. SHANNON. Adviser in Science and Mathematics, State Department of Public Instruction, Raleigh, N. C. BS, Appalachian State Teachers College; MEd, University of Missouri. Formerly, science teacher in schools of Forsyth County and Gastonia, N. C.; communication officer, USN. Member NSTA policy committee; served on research committee on school facilities for science instruction; member Harvard Conference on Nation-Wide Problems of Science Teaching; member N. C. Academy of Science and State Science Fair Committee. Has written for *North Carolina Education* magazine.

Director and Alternate Director, Region V
(Two-year terms)

EDWARD L. HAENISCH. Professor of Chemistry and Chairman of the Department, Wabash College. SB, PhD, University of Chicago. Formerly taught at University of Chicago, Montana State College, and Villanova University; was head of department at Villanova, 1941-49. Past chairman of Division of Chemical Education of American Chemical Society; member of the Division's Committee on Examinations and Teaching of College Chemistry; has served as director of several summer workshops and institutes sponsored by the Division. Co-author of several textbooks of chemistry; author of numerous articles in *Journal of Chemical Education.* Phi Beta Kappa, Sigma Xi.

PAUL KLINGE. Biology teacher and school business manager, Thomas Carr Howe High School, Indianapolis. AB, Butler University. Regional chairman (1953) for ASM-FSAF Science Achievement Awards; participant and speaker at several NSTA meetings; coeditor of *American Biology Teacher.* Has made special studies of and written extensively on "the gifted student" in

high school science. Phi Kappa Phi, Kappa Delta Pi; Ford Foundation Fellow, 1953.

VIOLET STRAHLER. Teacher of chemistry, Stivers High School, Dayton, Ohio. AB, Wittenberg College. Member NSTA Advisory Council on Industry-Science Teaching Relations; regional chairman (1954 and 1955) of ASM-FSAF Science Achievement Awards; Ford Foundation Fellow, 1952; Fellow of Ohio Academy of Science; editor of Ohio Academy of Science *Science Newsletter;* member of professional practices committee and high school committee of Dayton Section, American Chemical Society; member of state committee on Certification of Science Teachers in Ohio.

KENNETH E. VORDENBERG. Supervisor of Science, secondary schools, Cincinnati, Ohio, Board of Education. BScEd, MA, University of Cincinnati. Formerly teacher of general science, physics, and radio. Has served as NSTA North Central Regional Vice-president; member of Advisory Council and evaluation committee for Packet Service; member of 1953 Harvard conference on nationwide problems in science teaching. Editor of Curriculum Guides in *Electricity, Physics,* and *General Science;* author of numerous articles in *School Science and Mathematics.* Has held General Education Board Fellowship at University of Chicago; member AAAS, NEA, Ohio Academy of Science; Phi Delta Kappa; Kappa Delta Pi.

Director and Alternate Director, Region VII (Two-year terms)

SAM S. BLANC. Coordinator of AV aids and teacher of biology, East High School, Denver. AB, Colorado State College; MA, EdD, University of Denver. Has taught in Denver Public Schools since 1933. Regional chairman (1954 and 1955) of ASM-FSAF Science Achievement Awards; chairman of NSTA film preview committee; active in NEA department of audio-visual instruction. Co-author of *Biology Investigations* (Holt); author of about 40 articles on science teaching and audio-visual education published in various educational journals.

FREDERICK B. EISEMAN, JR. Chairman of science department, John Burroughs School, Clayton, Missouri. BS, MS (chemical engineering), University of Wisconsin; MA (education) Teachers College, Columbia University. Has served on NSTA committees and participated in meetings; member of several scientific societies such as Society for American Archaeology, American Meteorological Society, AAAS, ACS. Author of *The Why of Chemistry Problems* and *Supplementary Materials for Beginning Chemistry;* has written for several educational journals. Tau Beta Pi, Phi Delta Kappa.

HERBERT A. SMITH. Director, Bureau of Educational Research and Service, University of Kansas. BSc, MA, PhD, University of Nebraska. Formerly Associate Professor of Secondary Education and Supervisor of Science, University of Nebraska; science teacher and superintendent of schools in Nebraska. Has served several years on evaluation committee for NSTA Packet Service; also as regional chairman for ASM-FSAF Science Achievement Awards and as Nebraska state director; general chairman for NARST Third Annual Review of Research; Fellow of AAAS; recipient of Regents Scholarship and Brownell Scholarship in Science Education at University of Nebraska. Has written and published extensively on research of results from the use of educational sound motion pictures.

Director and Alternate Director, Region VIII (One-year terms)

GERTRUDE WITHERSPOON CAVINS. Head of Science Education Department, Professor of Chemistry, and Assistant Dean of Instruction, San Jose State College. AB, San Jose State College; MA, EdD, Stanford University. Has served as chairman of NSTA committee on affiliated groups; also as secretary of Pacific Southwest Association of Chemistry Teachers; is currently secretary of Elementary School Science Association of (Northern) California; is registrar and secretary of West Coast Nature School.

SISTER MARY CHARLOTTE (RAMSAY). Science teacher, St. Teresa's Academy, Boise, Idaho. BA, MA, University of Notre Dame; graduate work at UCLA, University of Texas, USC, and University of Chicago. Has held amateur radio license for six years (W7MUT); member Military Affiliated Radio System. NSTA state director for Idaho since 1952; Westinghouse Fellow at MIT, 1954. Directs radio club and camera club for her school.

JOHN H. MAREAN. Science teacher, Reno High School, Nevada. BSEE, University of Nevada; graduate work at University of Nevada, Massachusetts Institute of Technology, and Oregon State College. Operations officer Night Fighter Training Squadron, 1944; assistant director training and operations, Hammer Air Force Air Base. Westinghouse Fellow at MIT, 1953; Crown Zellerbach-FSAF Fellow at Oregon State College, 1954; director, western region, Nevada State Education Association, 1954-55; vice-president elect, DCT, NSEA, 1955-56.

ROBERT A. RICE. Chairman, science department, Berkeley High School, California. BA, MA, University of California. NSTA state director for California, 1948 to date; president, Lambda Chapter, Phi Delta Kappa; has served as treasurer, vice-president, and president of California Science Teachers Association, Northern Section; executive director San Francisco Bay Area Science Fair, 1955; meteorology instructor and civilian personnel officer, Army Air Corps, 1943-46.

FELLOWSHIPS—continued from page 24

obtained from National Science Teachers Association, 1201 Sixteenth St., N. W., Washington 6, D. C.

du Pont Summer Fellowships for Science Teachers. Specially designed, somewhat experimental programs being supported at several universities. Stress will be on science including basic concepts, modern developments, and teaching techniques. Programs likely will coincide with regular summer sessions. For the summer of 1955, 16 fellowships have been granted to the University of North Carolina and 12 each to the University of Delaware, Harvard, St. Louis, Cornell, Ohio State, and Columbia Teachers College. Selection of recipients is left to the institutions.

General Electric Fellowships for Science Teachers. Programs designed to provide new approaches to basic concepts and recent advances in the physical sciences. Courses are conducted at two institutions. **(1) At Case Institute of Technology. June 19-July 29.** Limited to physics teachers in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, Western Pennsylvania, Tennessee, West Virginia, and Wisconsin; fifty "all-expense" Fellowships available. *Write to Dr. Elmer C. Hutchisson, Dean of the Faculty, Case Institute of Technology, Cleveland 6, Ohio;* closing date for applications March 21. **(2) At Union College. July 3-August 12.** Open to "experienced secondary school teachers of science who expect to remain in the teaching profession" and holding at least a bachelor's degree with undergraduate courses in chemistry or physics and mathematics; limited to New England, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, and the District of Columbia; fifty "all-expense" Fellowships available. *Write to Committee on General Electric Fellowships, Wells House, Union College, Schenectady 8, New York;* closing date for applications March 1.

Westinghouse Summer Fellowships for Science Teachers. Two programs designed to provide a review of fundamental subject matter in physics, chemistry, and biology, together with a survey of recent

(Please continue on page 55.)

NSTA Activities

Report from Berkeley

The Berkeley regional meeting December 27-29, will long be remembered, both for the quality of the program and for the large attendance which it generated. Over 800 science teachers enjoyed and benefited from the general sessions, the research reports, the discussion groups, and the joint sessions conducted in cooperation with NARST, Section Q and the Cooperative Committee of the AAAS, and the Western Naturalists Society. California hospitality was revealed in all its bloom in the Mixer for which the Elementary School Science Association of Northern California (an NSTA affiliate) was host. About 350 sat together for luncheon at the "This Is Your NSTA" session. As usual, the "Here's How I Do It" sessions provided plenty of practical take-home items. President-elect Bob Stollberg and other members of his committees deserve congratulations on a superb job of planning and publicity.

Looking back over calendar year 1954, NSTA has held meetings in Chicago, New York City, Lake Texoma (Oklahoma), and Berkeley. Total attendance was over 2000. Looking ahead to 1955, there will be meetings in Cincinnati (March), Madison, Wisconsin (June), Atlanta, Georgia (December), and in the Arkansas-Texas and/or Arizona regions (October). All of which is in line with NSTA policy of providing or helping to provide professional meetings for *all* science teachers everywhere.

Looking Ahead to Cincinnati

The general planning committee for the Cincinnati convention has announced "everything under control and plans practically complete for the Third National Convention of NSTA." The dates are March 24-26; the place is the Netherland Plaza Hotel. The program provides realistic sessions devoted to many phases of science teaching in elementary schools, high schools, and colleges, as well as to other related problems and concerns.

The convention theme is, "More Realistic Science Teaching—Toward What Ends?" Nearly *three hundred* persons have already been secured to participate as major speakers, symposium and panel members, consultants to discussion groups, diagnosticians and prescribers in the clinics, and demonstrators in the "Here's How I Do It" sessions.

A copy of the complete, printed program will be mailed to all NSTA members. Advance registration forms are now being mailed. These also provide opportunity to make advance hotel reservations and reservations for tours and meal functions. It is advisable to make hotel reservations early since a high school basketball tournament will be held in Cincinnati the same weekend. Also, it is practically necessary to make tour reservations in advance because the number that can be accommodated is limited and the tours "take off" at 8:30 a. m. on the opening day of the convention.

Some of the special features for this year's convention include: (1) a dinner get-together of science supervisors; (2) an informal get-together of Ford Fund Fellows; (3) a breakfast for NSTA life members; (4) a luncheon with speaker and the Ohio Science Education Association as host; (5) continuous showings of science teaching films; (6) a "better than ever" Exposition of Science Teaching Aids.

It is hoped that many school systems will be represented at the convention by one or more teachers each from elementary, junior high, and senior high levels. There promises to be an unusually large number of college teachers from academic science departments as well as from departments of education. Many of the latter will be bringing some of their graduate and undergraduate students.

The Business-Industry Section of NSTA will serve as host for the Hospitality Night Mixer on Thursday, March 24, following an evening general session. The Section will have its business meeting Thursday morning. The Advisory Council will meet on Wednesday, March 23, both morning and afternoon.

The skeleton outline of the March 24-26 program is as follows:

Thursday, March 24

8:00 a.m.	Registration
8:00 a.m.	Exposition of Science Teaching Aids
8:30 a.m.	Tours (several options)
9:00 a.m.	Screening of Science Teaching Films
9:00 a.m.	Meeting of Business-Industry Section
1:30 p.m.	First General Sesssion—Keynote Speaker
3:00 p.m.	Symposia (five options)
6:00 p.m.	Dinner meeting of supervisors of science; NSTA committees may meet at this time also
8:00 p.m.	Second General Session—Speaker
9:10 p.m.	Hospitality Night Mixer

Friday, March 25

7:15 a.m.	State Group Breakfasts (to be arranged as desired by various groups)

8:00	**a.m.**	Registration
8:00	**a.m.**	Exposition of Science Teaching Aids
9:00	**a.m.**	Third General Session—Speaker
10:00	**a.m.**	Screening of Science Teaching Films
10:30	**a.m.**	Work-Discussion Groups (13 options)
12:00	**Noon**	Luncheons for NSTA Committees
1:30	**p.m.**	Reports on Research in Science and Implications for Teaching (five options)
3:00	**p.m.**	Screening of Science Teaching Films
3:30	**p.m.**	Work-Discussion Groups (continued)
7:00	**p.m.**	Banquet—Speaker; Announcement of Newly Elected NSTA Officers and Board of Directors; Presentation of American Society for Metals Recognition Awards

Saturday, March 26

7:15	**a.m.**	Breakfast for NSTA Life Members
8:00	**a.m.**	Registration
8:00	**a.m.**	Exposition of Science Teaching Aids
9:00	**a.m.**	Fourth General Session—Speaker
10:00	**a.m.**	Screening of Science Teaching Films
10:30	**a.m.**	Science Teaching Clinics (7 options)
12:15	**p.m.**	Ohio Science Education Association Luncheon—Speaker
2:15	**p.m.**	"Here's How I Do It" Session (4 options)
4:00	**p.m.**	1955 Convention closes
6:00	**p.m.**	First Meeting of Planning Committee for 1956 Convention to be held in Washington, D. C.

1955 Summer Meeting

The annual summer conference of NSTA and the annual meeting of the Board of Directors are held at or near the time and place of the annual convention of the National Education Association. The NEA will meet next July 3-8 in Chicago. Since last year's convention of NSTA was held in that city, our 1955 summer meeting has been scheduled for the University of Wisconsin, Madison, June 29-July 1. A planning committee under the chairmanship of Professor Ira C. Davis has the program structured and is now engaged in lining up speakers and other participants. Full details will be announced in the March or April issue of *The Science Teacher*.

This meeting is expected to have large appeal to NSTA members and other science teachers (1) who reside in or near Wisconsin; (2) who wish to combine a professional meeting with vacation and fishing in a "fisherman's paradise"; (3) who may be coming from some distance to attend the NEA convention; (4) who may find it not possible to attend other NSTA meetings during the year.

Publications Committee

Especially active among NSTA committees is the Publications Committee. They have produced the manu-

MARSH PHOTOGRAPHERS, INC.

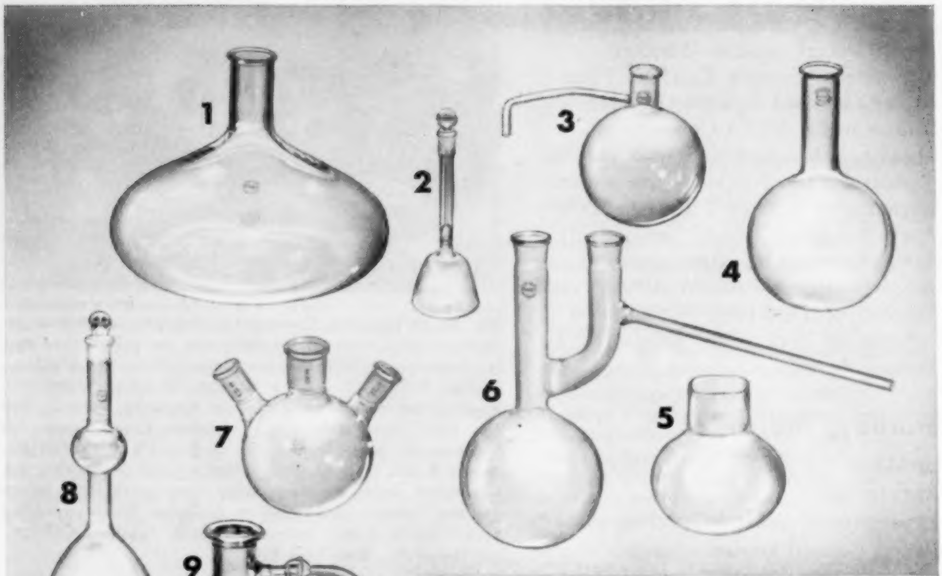
The Third National Convention planning committee in action. Photographed from left to right are: Mary E. Batiste and Robert H. Carleton, NSTA Headquarters Office, Washington, D. C.; Brother I. Leo, St. Mary's College, Winona, Minnesota; Bonnie Howard, Louisville Public Schools, Kentucky; John S. Richardson, The Ohio State University, Columbus; Louise Lyons, *Chairman*, Steubenville High School, Ohio; Kenneth E. Vordenberg, Cincinnati Public Schools, Ohio. Not present at the time the picture was taken were: Walter S. Lapp, Overbrook High School, Philadelphia, Pennsylvania; William F. Goins, Brooklyn College, New York City; S. Ralph Powers, *Emeritus*, Teachers College, Columbia University, New York City.

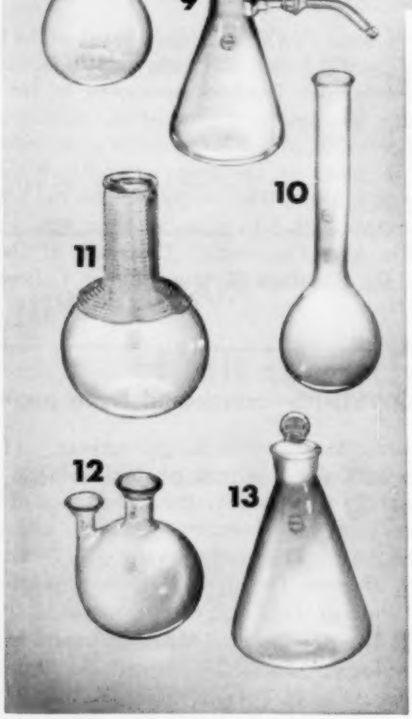
script for *Science Teaching Ideas II* based on the teacher entries in the 1953 and 1954 programs of Recognition Awards for Science Teachers, sponsored by the American Society for Metals. *Copies of this publication will be sent free to all NSTA members in good standing at the time it comes off the press,* after which the price will be $1.00 a copy. The committee also has a number of manuscripts with which to launch a new series of Science Teaching Pamphlets. Chairman of the committee is Dr. Abraham Raskin, Hunter College, New York City.

FELLOWSHIPS—continued from page 51

developments in these fields and others. **(1) The program at Case Institute of Technology. June 27-August 5.** Emphasizes the importance of fundamental concepts in chemistry, physics, and mathematics; fifty $250 Fellowships available. *Write to Dr. Borden P. Hoover, Director of Summer Session, Carnegie Institute of Technology, Pittsburgh 13, Pennsylvania.* **(2) The program at Massachusetts Institute of Technology. June 27-August 4.** Fifty $250 Fellowships available. *Write to Dr. Arthur R. Davis, Associate Professor of Inorganic Chemistry, Massachusetts Institute of Technology, Cambridge 39, Massachusetts;* closing date for applications April 1.

Summer Research Assistantships for Science Teachers. Twenty or more universities will offer awards of about $400 for qualified science teachers to serve as research assistants during the summer, working with researchers in biological, physical, and earth sciences. 1955 will provide a pilot run of the plan. *For information and application forms, write to NSTA, 1201 Sixteenth St., N. W., Washington 6, D. C.*





1. 4422—Low form culture flask; 2. 5500–Sligh Oxidation Flask; 3. 4880—Brown-Duvel Moisture Test Flask; 4. 4060—Flat bottom vial mouth boiling flask; 5. 4440—Kolle type culture flask; 6. 4740—Claisen Distilling flask; 7. 4965—3-neck Distilling Flask $ joints; 8. 5760—Giles Volumetric flask; 9. 5350—Filter flask with ball joint connection; 10. 5420–Flask for Kjeldahl determination; 11. 4220—Wicker neck flask for wash bottle use; 12. 4970—2-neck Distilling Flask, socket joints; 13. 5020—Stoppered Erlenmeyer Flask.

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FSA Activities

Summer Opportunities

The Foundation is working hard to arrange a wide program of summer opportunities for science teachers. A 1955 West Coast Science Teachers Summer Conference has been assured. Although only teachers in the seven Western States are eligible for this program, their research assignment will be of interest to all teachers. This assignment is to identify mathematical skills which are hazards to young people who are looking toward careers in science. As in 1954, the team will interview university, government, and industrial scientists. To put their suggestions into action, new science-mathematics exercises will be written. This will be the counterpart of the laboratory exercises which appear in this issue of *The Science Teacher*.

The Foundation is conducting a 1955 pilot run of another type of summer program. At least twenty universities which conduct full-scale research programs will offer one or more High School Science Teachers Summer Research Assistantships. Each assistantship will provide $400 compensation plus free tuition for one course. The teachers will work approximately 400 hours assisting in the development of individual research projects. Announcement-application forms may be obtained from the Foundation. Applications close April 10.

Industries will continue to provide science-related summer jobs. The Foundation has studied experiences with this program. Values as well as hazards are becoming more and more clearly defined. Even at the risk of being disappointed, teachers should feel free to seek summer jobs in industry.

Financial Support of the Foundation

Already in 1955, six new firms have joined our supporting group. One former contributor increased its contribution by 250 percent. Everything points toward the FSAF becoming a strong force toward helping science teachers improve their teaching.

Science Achievement Awards for Students

It is still our goal to have at least one student entry in 1955 from each NSTA member.

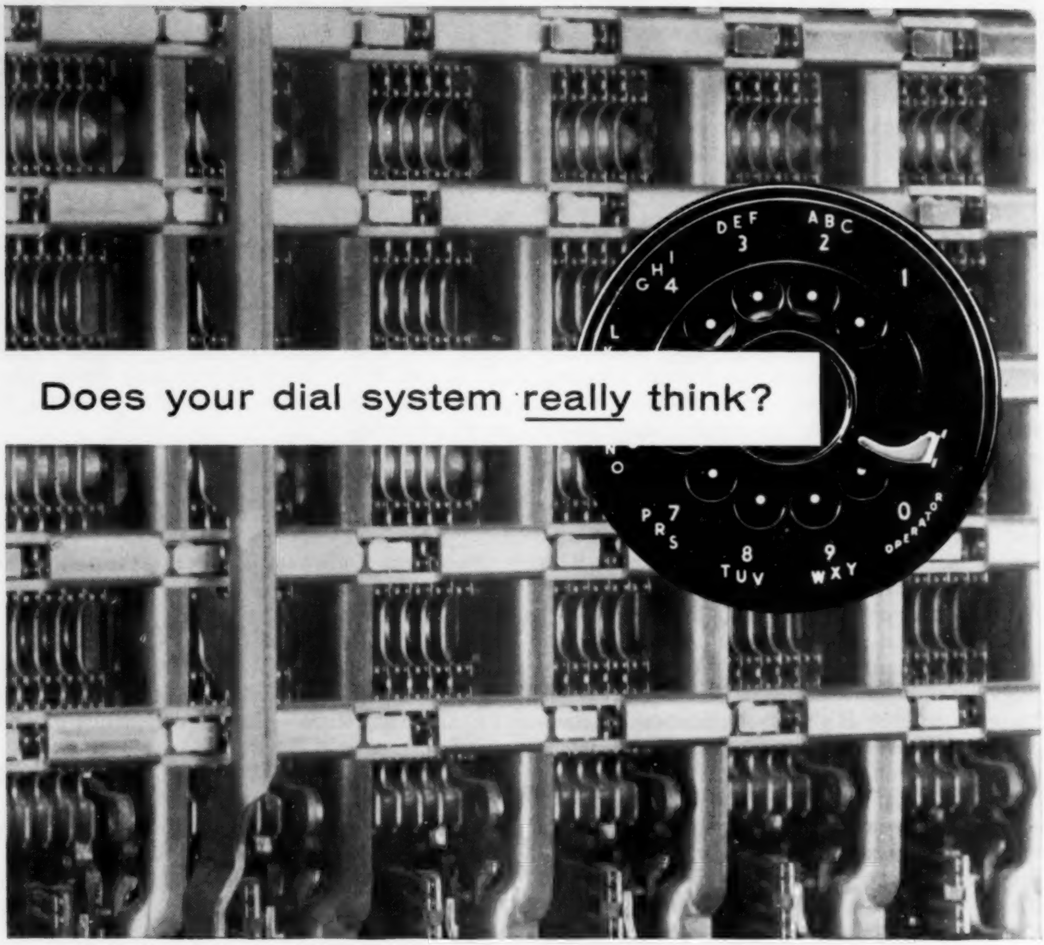
FSA Science Student Chart-Making Contest

Be sure your entries in this program are mailed to the W. M. Welch Scientific Company before March 1. Everything points toward quite a show at the Cincinnati Convention.

What Is Your Score?

How many times have you, during the past semester—

1. Suggested a project for the FSAF to develop or sponsor?
2. Criticized an FSAF activity?
3. Shown *Careers in Science Teaching* to appropriate high school students or done other career counseling?
4. Guided a student through completion of a project and reporting of it for the FSA-ASM Student Awards program and/or the Westinghouse Science Talent Search?
5. Encouraged a student to prepare a science teaching chart for the FSA chart making contest?
6. Submitted a "here's how I do it" for *The Science Teacher?*
7. Attended a science teachers' meeting; local, state, or national?
8. Read a science teaching journal?
9. Developed a new or modified demonstration or laboratory exercise?
10. Written up one of your new science teaching ideas for the FSA-ASM Teacher Recognition Awards program?
11. Scheduled and/or previewed a science teaching film?
12. Visited another science teacher in action?
13. Obtained a free or low cost sponsored teaching aid?
14. Visited one industrial, government, or university research laboratory?
15. Submitted any kind of article for any science teaching journal?
16. Applied for a science-related summer job?
17. Encouraged a student to enter a school or regional science fair?
18. Offered to take part in the arrangements and/or program of a science teachers meeting?
19. Watched a science-related TV program?
20. Attended a museum or planetarium program?



Part of the control equipment of a modern dial system—dial telephony's equivalent of a brain. It goes into action the instant you dial a call, selecting the telephone you want to reach and directing the switches that set up the connection . . . just as the brain directs the muscular actions of the body.

This question can't be answered until we learn more about the nature of thought. But dial telephone systems *do* simulate many of the processes of the human brain. For example, when a number is dialed, Bell's newest switching system—

COUNTS the dial pulses

REMEMBERS them

DECIDES ON the best route to a nearby town or across the nation

TESTS to see if the route is clear

SELECTS an alternate if the first route is busy

REPORTS difficulties in circuits, if any

Today's automatic switching reflects the creative thinking of many scientists and engineers at Bell Telephone Laboratories. Each year your dial telephone is able to do more for you. And this is but one phase of the continuing effort to keep your Bell telephone service the world's best.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

Audio-Visual REVIEWS

"Science Films Preview Committee Set Up In Metropolitan Area." *The Colorado School Journal.* This was the first announcement of another service of NSTA to science teachers.

Sub-committees for primary, intermediate, junior high, senior high (biological science), and senior high (physical science) have been organized by Sam Blanc, *Chairman,* East High School, and Paul Wilkinson, *Vice-chairman,* Manual High School, Denver. They will screen, evaluate, and recommend the curricular use of new films and filmstrips. Science teachers in the area who are interested in attending preview sessions are cordially invited.

We are pleased to introduce this new column in *The Science Teacher* to bring you their reviews. Your comments and reactions will be appreciated.

CHEMISTRY OF STEEL. 50-frame filmstrip, 1954. Color. Available free from American Iron and Steel Institute, 350 Fifth Ave., New York 1, N. Y.

Recommendation: Suitable for senior high school chemistry. It might also be used on junior high level.

Content: Preparation of steel and alloys in modern steel plants is shown. Traces the complete process from charging the furnaces to rolling the slabs. Discusses properties and grades of various steels and alloys.

Evaluation: Has excellent photography in color. Captions on each frame are self-explanatory. Has a correlated and illustrated Teachers' Manual. Filmstrip is well-organized as to content, and is up-to-date and timely. Advertising is practically non-existent.

IN THE BEGINNING. 28 min. sound, 1954. Color. Available for schools, colleges, and adult groups; no charge except for postage. Film Library, Socony-Vacuum Oil Company, 26 Broadway, New York 4, N. Y.

Recommendation: Suitable for use on the high school and college levels. Useful as an introductory and motivating lesson in any course dealing with geology, and as a specific teaching aid for the study of past geological ages in biology.

Content: Presents the story of geologic time as written in the walls of the Grand Canyon. Beginning with the Archeozoic era, the forces of mountain building, erosion, and sedimentation are graphically portrayed for each of the major eras through the Cenozoic. The portrayal results in a motion picture so realistic that one feels that the camera must have been on the scene filming the earth as it actually evolved through the countless centuries of time. This is a film without a cast or a single living being. By means of superb photography and a beautifully orchestrated score, a dramatic picture is produced in which the star is time itself. Stresses natural features, geologic history, ecological factors, and erosive forces.

Evaluation: An excellent audio-visual approach in presenting an extremely complex topic. The color photography and sound are outstanding. The narration is by two contrasting voices to represent the past and the present. The commentary, in spite of its non-technical approach, is designed for senior high school and adult levels.

SOUNDS ALL ABOUT US. 11 min. sound, 1954. $55 B&W, $110 Color. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Suitable for intermediate grades and up to seventh grade general science. Should be useful to introduce the study of sound.

Content: A boy becomes aware of the world of sound which exists all about him. Through experimentation with a tuning fork, he discovers that sounds are caused by vibrations or movement of different objects. Various sounds which all children will recognize are used to demonstrate that sounds can differ in pitch, in loudness, and in quality.

Evaluation: Although it uses a somewhat juvenile approach, the facts presented are basic and should stimulate discussion, reading, and experimentation. Photography and sound are good. Is accompanied by a Teachers' Guide.

ANIMAL HOMES. 11 min. sound, 1954. $50 B&W, $100 Color. Churchill-Wexler Films, 801 N. Seward St., Los Angeles 38, Calif.

Recommendation: Suitable for primary through eighth grade in nature study and elementary biology. Could be used with adult groups as a general interest program.

Content: A variety of animals are seen making and living in their homes. Shows the cliff swallow, red-wing blackbird, ant, spider, gallfly, mole, gopher, opossum, and coatimundi each in native environments. Explains that an animal uses a home for: safety, shelter, food-storage, and raising of young.

Evaluation: Suitability and organization are timely and well-done. Material is presented through excellent photography and sound. Good for stimulating reading, and building of wholesome attitudes towards wildlife.

THE FARMER'S ANIMAL FRIENDS. 6 Filmstrip Series, 1954. $29 Color. Jam Handy Organization, 2821 E. Grand Blvd., Detroit 11, Mich.

Recommendation: Suitable for primary level in science and social studies.

Content: Visualizes the visit of two children to their uncle's farm. Shows the everyday life of familiar farm animals such as cows, horses, pigs, sheep, chickens, and cats. Illustrates how these animals care for their young, what they eat, and where they live. Explains how the animals help us, and how the farmer cares for them.

Evaluation: Excellent series for classroom use with small children. Good color photography. Presents real-life situations involving children and farm animals.

Book Reviews

CHEMISTRY: A COURSE FOR HIGH SCHOOLS, Third Edition. John C. Hogg, Otis E. Alley, and Charles L. Bickel. 772 pp. Illustrated. \$4.12. D. Van Nostrand Company, Inc. New York. 1953.

Chemistry teachers who are familiar with the first two editions of Professors Hogg, Alley and Bickel's chemistry text will welcome this third edition. This new edition has not only been almost completely rewritten, but, as the authors state, "the chapters on atomic structure, radioactivity, and uranium have been expanded and brought up to date."

The book is divided into ten units, the first six of which have been so written as to insure ample presentation of the basic principles and facts which a student of high school chemistry should master. The sixteen chapters of the last four units are designed to provide flexibility.

The format of the book is attractive, the illustrations are good, the glossary is ample and provides definitions that are simple and clear, and the "Things To Remember" and problem sets at the end of each chapter are quite helpful.

The authors state in the preface that Units I through VI should be studied in the order in which they appear but this reviewer prefers to take the chapters on the Modern Atomic Theory directly after the chapters on Dalton's Theory and Chemical Shorthand, respectively; also, colloids seem to be understood better by high school students if they are taught after water, rather than after the Periodic Table.

Summarily, this book seems to me to contain more chemistry than any other high school text I have seen. It provides the more interested student with a wealth of information, allows the teacher a certain versatility in presenting her course, and will be a handy reference book for the student in his later years.

SISTER MARY CASIMIR, R. S. M.
Camden Catholic High School
Camden, New Jersey

PHYSICS FOR THE NEW AGE (Revised Edition). Robert H. Carleton, Harry H. Williams, Mahlon H. Buell. 656 pp. J. B. Lippincott Company. New York. 1954.

This new edition of a standard high school physics text will have a good reception. The authors have retained the commendable pattern of the 1947 edition, that of combining the systematic organization of traditional physics with the life situation approach.

The book is designed to be used with students of a wide range of ability; there are "honor credit problems", suggested readings, and interesting things to do for the talented and ambitious students.

Among the useful teaching devices are: a stimulating preface for the student; the introduction of each new subject as a problem (question); the presentation of quantitative principles as word equations and also in symbols. In addition, such principles are printed in heavy type or italics. The appendix contains tables of physical data, a glossary of several hundred words, and a complete index. The typography is clear and the illustrations are generous.

The book is as up-to-date in method and content as such a book can be. Revisions of the 1947 edition include the latest developments in motion picture technique (cinemascope and cinerama), color TV, and electronics.

The authors, experienced teachers, administrators, and educational consultants, have successfully combined scientific facts and everyday experiences with good psychology.

M. M. HASSE
Central High School
Aberdeen, South Dakota

THE BOYS' FIRST BOOK OF RADIO AND ELECTRONICS. Alfred Morgan. 229 pp. \$2.75. Charles Scribner's Sons, New York. 1954.

This book should easily find its way to the book shelf of any science library because it contains much information in the field of electronics at a level that can be understood by most junior high school students.

The author begins with an interesting, historical background of this area and then moves into a discussion of basic electronic theory, covering electricity, radio waves, electron tubes and many other similar topics. The final third of this book is spent in describing how to build simple crystal and one-tube radio sets. Circuit and pictorial diagrams are included in the text as well as complete lists of materials required to construct each receiver at minimum cost.

WILFRED H. HUPP
Marion-Franklin High School
Columbus, Ohio

SCIENCE FOR HERE AND NOW. 213 pp. \$1.92. SCIENCE FAR AND NEAR. 279 pp. \$2.20. Herman and Nina Schneider. D. C. Heath and Company. Boston. 1954.

These books for grades two and three respectively are a part of a six year series for use in the teaching of science in an elementary school. The books themselves are quite attractive physically. Brilliant bindings of green and blue have white animal and bird tracks on which is printed an interesting picture of a science activity appropriate to the age level of the second or third grade child.

Each book deals with a wide variety of topics of general interst to and within the experiences of children in the primary grades. The second grade book contains 18 areas including the following examples: "Your Day", "Why We Use Glass", and "Weather". The 15 topics discussed in the third grade book include such subjects as: "The Earth's Cover", "The Ocean", and "Forest Plants". All information presented is accurate. At the conclusion of each chapter children are further stimulated to review and to do additional research and experiments by a page or two devoted to "Things to Do", "Things to Talk About", and "Things to Find Out".

The books are well planned with beautifully colored drawings and illustrations of experiments which add to the understanding of science concepts. Both books meet the requirements of the particular grade's readability. A grade placement of 1.7 is given for book two and 2.3 for the third grade book. An analysis of the vocabulary is given along with the page presentation of all new words.

In summary, both books are excellent. They may be used as a basic guide in the teaching of elementary science or be added to the library shelf of acceptable science books. Again, too, they will be well received by the older girl or boy who has reading difficulties.

FLORENCE E. LEARZAF
John Morrow School
Pittsburgh, Pennsylvania

HEALTH AND SAFETY FOR YOU. Harold S. Diehl and Anita D. Laton. 515 pp. McGraw-Hill Book Company, Inc. New York. 1954.

This book will probably be used largely as a textbook in courses in personal care, health, and hygiene in the upper grades of the senior high school. Its contents are drawn very largely from the fields of anatomy, physiology, and hygiene.

This book has a very attractive format, and is well and copiously illustrated. One wonders why the publisher could not have taken a few more photographs himself, and thus eliminated photo credits in bold type to manufacturers of specific drug products. Each chapter of the book ends with a summary, evaluation material and a list of suggested activities for pupils. The book also contains a bibliography and a glossary.

The reviewer feels that serious shortcomings of this book are the complete absence of any discussion of intersexual relationships and human reproduction and the rather incomplete treatment of the narcotics problem. More emphasis should have been given to the prevalence of addiction among teenagers and to the treatment and rehabilitation of addicts.

ABRAHAM RASKIN
Hunter College
New York City

THE YOUNG ENGINEER. Charles B. Broschart. 243 pp. \$3.00. Exposition Press. New York. 1953.

The author of this book is an engineer who is also the father of an inquisitive, teen-age son. The father's efforts to satisfy the almost insatiable curiosity of his son led to the idea of writing a book designed to "help all 'questioning' sons and all 'answering' fathers." The author has attempted, with a considerable degree of success, to explain the operation of various common devices and the occurrence of certain natural phenomena in language intelligible to the average teen-ager. The author has also endeavored to make his young readers interested in considering the possibility of selecting a future career in one of the fields of engineering.

The book is divided into seven sections entitled: "Kites and Airplanes"; "Ships"; "Engines"; "Transportation"; "Natural Phenomena"; "Electrical Devices"; and "Miscellaneous". Under the last heading appear such topics as movies, telescopes, measurement of the speed of light, curving of pitched balls, and operation of cameras. The explanations are presented in a clear, informal manner. There is a refreshing absence of technical terminology and jargon

which so frequently are found in books of this type and which tend to destroy the curiosity and interest of young people referring to these books for explanations of phenomena in the world about them.

The most obvious weakness of this book is found in the illustrations, which may be described as extremely amateurish, and which are frequently far from clear. Despite this shortcoming the book is a valuable and worthwhile addition to the science teacher's library. It should also do a good job of serving its original function of helping parents answer some of the science questions asked of them by their teen-age sons and daughters.

HAROLD S. SPIELMAN
City College of New York
New York City

KEY-TEXT IN CHEMISTRY. Vinton R. Rawson. 317 pp. $0.75. Keystone Education Press. New York. 1954.

Key-Text in Chemistry should be a valuable supplementary study aid, and this is its announced purpose. It has ample content without presenting the appearance of a paper-bound textbook. The conciseness and lucidity of an outline are achieved without strict adherence to the outline form. A numbered question heads each paragraph, and each paragraph answers a question tersely. This style should help the student to recognize and retain the more important information in high school chemistry.

Self-testing material, including 110 answered problems, and complete Regents Examinations are part of the appendix. The book is well indexed.

JOHN C. ROSEMERGY
Senior High School
Ann Arbor, Michigan

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